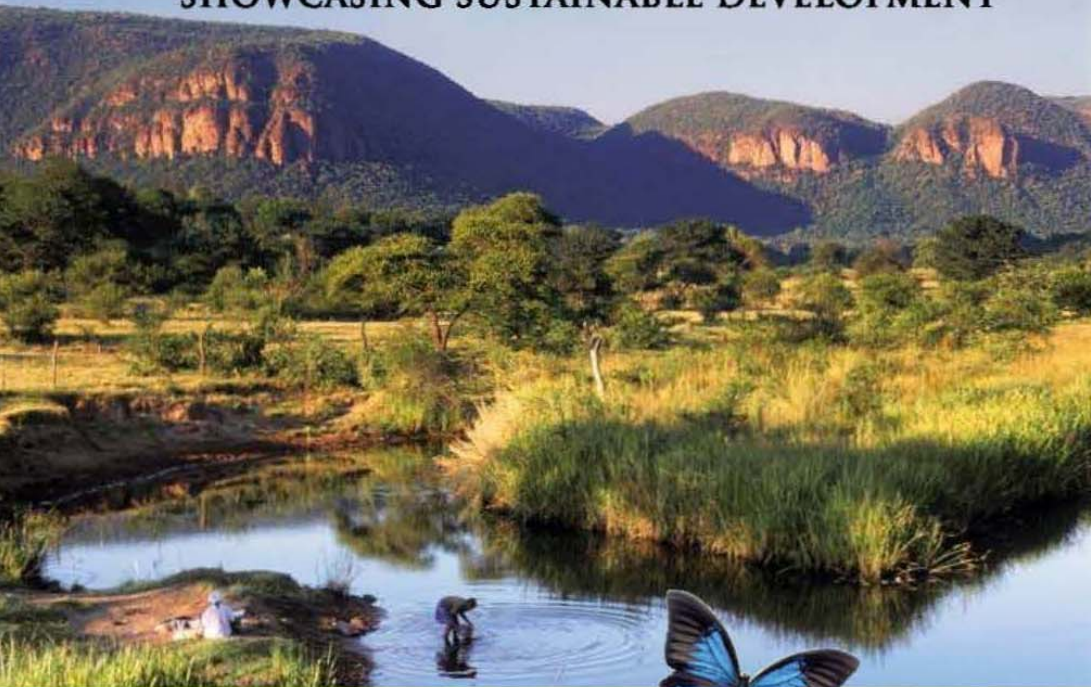




AFRIMAB

BIOSPHERE RESERVES IN SUB-SAHARAN AFRICA: SHOWCASING SUSTAINABLE DEVELOPMENT



EDITORS:
**RUIDA POOL-STANVLIET
& MIGUEL CLÜSENER-GODT**

Biosphere reserves are sites established by countries and recognized under UNESCO's Man and the Biosphere (MAB) Programme to promote sustainable development based on local community efforts and sound science.

As places that seek to reconcile conservation of biological and cultural diversity and economic and social development through partnerships between people and nature, they are ideal to test and demonstrate innovative approaches to sustainable development from local to international scales.

After their designation, biosphere reserves remain under national sovereign jurisdiction, yet they share their experience and ideas nationally, regionally and internationally within the World Network of Biosphere Reserves (WNBR).

There are currently 610 biosphere reserves in 117 countries. Sub-Saharan Africa is home to 64 biosphere reserves in 28 countries.

This publication represents an important contribution of African biosphere reserves towards the implementation of the MAB Programme on the continent of Africa.

AfriMAB

Biosphere Reserves in Sub-Saharan Africa:
Showcasing Sustainable Development

AFRIMAB

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SHOWCASING SUSTAINABLE DEVELOPMENT



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RUIDA POOL-STANVLIET
& MIGUEL CLÜSENER-GODT

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Foreword

by the Division of Ecological and Earth Sciences, UNESCO

The World Network of Biosphere Reserves is one of UNESCO's most important programmes, as it combines in an integrative manner the conservation of nature with sustainable development. Today, this network counts 610 sites in 117 countries across the world, stretching from terrestrial to coastal and marine ecosystems, from high mountain peaks to deep ocean abysses.

In Sub-Saharan Africa, there are 64 biosphere reserves in 28 countries. This publication provides an overview of the unique role of biosphere reserves for sustainable development and nature conservation in the continent. African countries implemented this concept very early as soon as 1976 when the first sites were recognized. At that time, biosphere reserves were seen as protected areas and research sites only. In the wake of the 2nd World Congress of Biosphere Reserves, held in 1995 in Seville, Spain, biosphere reserves have become land and seascapes dedicated to exploring the principles and practice of sustainable development. Today, biosphere reserves are places for people and nature to co-exist and to interact in ways that will guide sustainability into the future.

In February 2008, the 3rd World Congress of Biosphere Reserves was held in Madrid, Spain, under the title "Learning Sites for Sustainable Development". This Congress elaborated the Madrid Action Plan for Biosphere Reserves 2008–2013, which calls for more cooperation between the sites, further development of the network and enhanced information and communication among the biosphere reserves. To achieve this end, this book presents a selected list of sites in Africa with an outline of their natural ecosystems, human presence and activities. Information is also provided on the conservation, income generation and research and learning activities that highlight the role of each biosphere reserve in promoting the sustainable development of the surrounding region. As the International Co-ordinating Council of the Man and Biosphere Programme prepares for the evaluation of the Madrid Action Plan, this book provides new insights on the achievements and challenges regarding the World Network.

I would like to use this opportunity to express our sincere gratitude to the Spanish Ministry for Agriculture, Food and Environment with its Autonomous Organisation for National Parks for its longstanding support to the Man and the

Biosphere Programme. Without such backing from Member States, the World Network would not have come as far as it has today. The 2011 UNESCO General Conference reiterated the importance of the Man and the Biosphere Programme and the World Network of Biosphere Reserves as platforms for learning about sustainable development. Ten to twenty new sites join the Network every year, including in Africa. Many have reviewed their zonation, scope and goals in order to try to achieve the sustainable development priorities of the regions in which they are located. New proposals take all recommendations of the Madrid Action Plan into consideration and are deeply committed to sustainability.

Finally, I trust that this publication, whose preparation was entrusted to the UNESCO Secretariat and the MAB National Committee of South Africa at the AfriMAB Meeting, held in Nairobi in 2010, will provide extensive information about case studies and research thus offering guidance for practitioners and policy-makers. The editors of this publication hope that it will be the first of a series of publications on African case studies as sites for sustainable development in action. The continued progress of this network in the African region is of utmost importance to its development and nature protection for the benefit of its people.

**THOMAS SCHAAF***Director a.i., Division of Ecological and Earth Sciences, UNESCO*

Foreword

by AfriMAB

One of the challenges of sustainable natural resources management in most African countries today is how to simultaneously help preserve biological diversity, enhance development and empower the poor rural people. The AfriMAB Book Project showcases the role of “Biosphere Reserves” as a concept and a tool for development and conservation of natural resources in Africa.

Without doubt, the biosphere reserve concept is one effective tool meant to achieve long-term conservation objectives and sustainable development. In the same context, the biosphere reserve concept reinforces the effectiveness of ecosystem management approaches. The papers presented in this book are meant to encourage the relevant and concerned authorities in Africa to consider designating more sites as biosphere reserves, especially those with unique ecosystems which are most likely threatened with encroachment for development purposes.

The concept of “Biosphere Reserves” is one of the important standard bearers of what has been referred to, in the Convention on Biological Diversity as the “*ecosystem approach*”. Unlike the “protected area approach” biosphere reserves are designed from the start to get the local people involved in conserving and managing biodiversity while at the same time meeting their livelihood needs. This is achieved through sustainable utilization of natural resources in the buffer and transition areas. Thus, biosphere reserves seek to reconcile local communities’ economic development with the conservation of biodiversity.

Biosphere reserves are designated by the UNESCO-MAB program to deal with one of the most sensitive and complex conservation questions the world and in particular, most developing countries in Africa are facing today: that is, how to reconcile conservation with development. An effective biosphere reserve involves natural and social scientists, conservation and development groups, management authorities and local communities — all working together to tackle the complex issues of combining conservation and development.

Biosphere reserves provide a framework for sustainable integrated natural resources management and development covering all types of ecosystems’ elements including areas of high natural biodiversity, whether conserved or used sustainably for human settlements, for agriculture or any other land-use system, particularly those based on ecosystem management principles.

AfriMAB considers this book project as one the efforts towards addressing the Madrid Action Plan's (MAP) "capacity enhancement" domain for Africa. It will serve as an empowering tool for MAB national committees and biosphere reserve managers in Africa.

AfriMAB wishes to acknowledge the editors of this book and all the authors for their commitment towards addressing conservation challenges in Africa through this book project.



PAUL M. MAKENZI
Chair AfriMAB

Foreword

by the National Department of Environmental Affairs

South Africa is endowed with a wealth of biological diversity and is regarded as one of Earth's 17 biologically wealthiest countries. The South African government has adopted an outcome-based approach to improve performance and service delivery. South Africa has therefore identified 12 main outcomes of which Outcome 10 reads: "Environmental assets and natural resources protected and continually enhanced". Our country, much like many countries around the world, is facing the interrelated pressures of increasing human footprint and the effects thereof on the environment. We thus have to find more sustainable means of supporting future livelihoods for all our people.

The concept of the Man and the Biosphere Program of UNESCO provides a demonstrable option for creating better living conditions while at the same time addressing conservation of biodiversity. The Department of Environmental Affairs (DEA) supports the implementation of the MAB Program through designated biosphere reserves. The core areas of such biosphere reserves include legislated protected areas listed according to the National Environmental Management: Protected Areas Act 57 of 2003. South Africa is a signatory to the Convention on Biological Diversity and is actively pursuing the expansion of its conservation estate to include at least 12% of a representative sample of its biodiversity under formal conservation, including terrestrial, marine and freshwater realms. At national level, biosphere reserves have been earmarked as a valuable tool to assist with the protected areas expansion strategy.

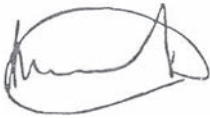
In 2008, a national biosphere reserve position paper was developed. It stated that the MAB Program could play a prominent role in government strategies related to poverty alleviation, environmental sustainability, social upliftment, transformation and economic development. Thus DEA supports the vision for South African biosphere reserves as stated in the position paper: "South African Biospheres are special landscapes where socio-ecological land management is practiced towards a more sustainable future for all." DEA has established a National MAB Committee that meets regularly to evaluate new biosphere reserve nominations and provides a platform for information exchange between all biosphere reserves. The overall goal of the MAB Committee is to enhance co-operative governance between DEA,

x | **AfriMAB**

Biosphere Reserves in Sub-Saharan Africa: Showcasing Sustainable Development

the South African National Commission for UNESCO, the nine provincial government departments and conservation agencies, by providing strategic and technical direction and support to ensure the effective implementation of the MAB Program in South Africa. DEA is continually exploring ways of supporting the country's biosphere reserves. Currently there are six UNESCO designated biosphere reserves and a further three are in various stages of the nomination process.

DEA believes that this book showcasing African biosphere reserves, will contribute towards sharing stories and efforts on how to achieve a balanced relationship between humans and the natural environment. In this way we could support each other in our quest for biodiversity conservation while at the same time create more sustainable living conditions for all people.



FUNDISILE MKETENI

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Department of Environmental Affairs, South Africa*

Preface

by the Editors

When considering a descriptive word that would encompass the magic that is the continent of Africa, 'diversity' is the one that comes to mind, as well as the notion of an inherent connectedness of its beautiful people to the earth. Africa is a country that is all about vast open plains, the masses of different species of wild animals, mountains, forests, a golden sun constantly warming our diverse vegetation and multiple beautiful natural water sources. And yet this is not all that constitutes the continent, it is also about crowded cities, denuded rural areas and a struggle for survival of some of its many people. It is about a distinct and constant co-existence between humans and nature. There is a need for sustainability in its broadest sense and for true living landscapes to secure the future of this vast continent's natural resources and people. This book provides a peek into life amongst Africa's diversity.

The UNESCO MAB regional network for Africa, AfriMAB, was established in 1996. It covers Africa south of the Sahara, including Madagascar, and comprises Anglophone, Francophone and Lusophone parts of the continent. Members of AfriMAB include 64 biosphere reserves in 28 countries.

The idea of a book on African biosphere reserves came to being during an AfriMAB meeting in September 2010 in Nairobi, Kenya. The result acuminated in this book, including 21 papers from 9 countries. We would like to express our thanks to all authors and co-authors for their valuable contributions. All papers were subjected to a scientific peer review process and we would like to extend a word of thanks to both the English and French reviewers for their professional assistance.

The production of the book was a group effort and herewith we would like to acknowledge the valuable assistance from the following institutions, without whose support this book would not have been possible: the Division of Ecological and Earth Sciences at UNESCO MAB in Paris, France for administrative assistance and financial support; the National Department of Environmental Affairs, South Africa for financial contributions towards printing costs, and both CapeNature and the Cape Winelands Biosphere Reserve of South Africa for their financial contributions and valuable support. CapeNature is also thanked for their generous allowance of time that was needed for editorial tasks.

In this book, the biosphere reserve fraternity of Africa shares stories of sustainable development, as portrayed through management of biosphere reserves. These papers are meant to exchange knowledge, inform learning, share experiences and guide future thinking about the implementation of the MAB Program in developing countries.

Readers are invited to share our stories, in an intellectual and emotional way, and to experience life in biosphere reserves as it plays out on a daily basis in our beloved Africa.



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The Biosphere Reserve Concept as a Tool for Sustainable Natural Resource Management in the Eastern Africa Region

Le concept de réserve de biosphère comme outil de gestion durable des ressources naturelles dans la région de l'Afrique de l'Est

PAUL M. MAKENZI¹

Abstract

Eastern Africa is a region of diverse biological richness. A range of climatic and geographical characteristics give rise to both aquatic and terrestrial ecosystems ranging from rich marine ecosystems, through savannah woodlands, arid and semi-arid areas, to unique afro-montane ecosystems. However, environmental degradation arising from depletion of biodiversity, deforestation and the resultant problems such as soil erosion, climate change and poverty, has become an issue of global concern. Today, this region faces a serious ecosystem management challenge as a result of the increasing environmental degradation. Of special concern, unfortunately, is that the areas where the biodiversity is at most risk are mainly those rural areas which are home to the desperate poor in need of various aspects of development endeavours to meet their livelihood needs. For example, food production in such areas must be intensified to meet the increasing demand and to keep up with rapid increase of populations, yet agricultural related activities as traditionally practised have remained the major cause of destruction of valuable habitats, pushing species towards extinction. The formal traditional conservation methods through the “protected areas” approach which was based on total exclusion of any form of human activities in conservation areas seem not to be effective as result of increasing conflicts of interests between development and conservation. Application of the UNESCO MAB programme’s biosphere reserve concept as a conservation tool seems to be a viable option.

The biosphere reserve concept is premised on the belief, borne out of empirical evidence, that human beings and wild species can share common ground and prosper in conservation of natural resources. Sustainable development and effective

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conservation can occur on the same land through sound science and policy. This is the basis within which the biosphere reserve concept was conceived.

This paper presents the broad ecosystems of eastern Africa and issues that threaten them. Operationalizing the biosphere reserve concept is presented as one of the tools for ecosystems management in eastern Africa. It can add to other efforts by development agents, scientists and environmentalists in their search for methods to conserve biodiversity and habitats while allowing development for improvement of the livelihoods of the poor especially in the tropics.

Key words: Biosphere reserves, ecosystem management, sustainable management

Résumé

L'Afrique de l'Est est une région présentant une richesse biologique diversifiée. Une série de caractéristiques climatiques et géographiques donne naissance à des écosystèmes aquatiques et terrestres comprenant aussi bien de riches écosystèmes marins que des bois de savane, des zones arides et semi-arides et des écosystèmes afro-montagnards uniques. Malgré tout, la dégradation environnementale découlant de la diminution de la biodiversité, la déforestation et les problèmes associés comme l'érosion du sol, le changement climatique et la pauvreté sont devenus un souci de préoccupation mondiale. Aujourd'hui, la région est confrontée à un sérieux défi de gestion de l'écosystème en résultat de la dégradation environnementale croissante. Tout particulièrement, hélas, les zones où la biodiversité est le plus à risque sont surtout les zones rurales, habitées par les pauvres désespérés, bénéficiant des divers aspects des efforts pour satisfaire à leurs besoins de subsistance. Par exemple, la production agricole dans ces zones doit être intensifiée pour satisfaire la demande croissante et s'adapter à l'augmentation rapide des populations mais en même temps, les activités liées à l'agriculture telles que pratiquées traditionnellement restent la cause majeure de destruction des habitats précieux, poussant les espèces vers l'extinction. Les méthodes formelles et traditionnelles de conservation par l'approche des 'zones protégées' qui était basée sur l'exclusion totale de toute forme d'activités humaines dans les zones de conservation ne semblent pas prouver leur efficacité en résultat des conflits d'intérêt croissants entre le développement et la conservation. L'application du concept de réserve de biosphère du programme MAB de l'UNESCO en tant qu'outil de conservation semble offrir une option fiable.

Le concept de réserve de biosphère repose sur la croyance, née de preuves empiriques, que les êtres humains et les espèces sauvages peuvent partager un terrain commun tout en prospérant en matière de conservation des ressources naturelles. Le développement durable et la conservation efficace peuvent s'épanouir sur des terres communes en s'appuyant sur des sciences et des politiques rigoureuses. Le concept de réserve de biosphère a été conçu sur cette base même.

Ce document présente les écosystèmes de l'Afrique de l'Est dans leur ensemble et les problèmes qui les menacent. L'application opérationnelle du concept de réserve de

biosphère est présentée comme l'un des outils de gestion des écosystèmes en Afrique de l'Est. Elle peut compléter les efforts entamés par les acteurs du développement, les scientifiques et les défenseurs de l'environnement dans leur quête pour des méthodes de préservation de la biodiversité et des habitants tout en laissant de la place pour l'amélioration des niveaux de vie des pauvres notamment sous les tropiques.

Mots-clés: Réserves de biosphère, gestion de l'écosystème, gestion durable

1. Introduction

The Eastern Africa region comprises nine countries: Kenya, Tanzania and Uganda as well as Ethiopia, Somalia, Eritrea, Djibouti, Rwanda and Burundi (Figure 1). However, under the UNESCO countries clustering systems, Madagascar, Seychelles, Mauritius and Comoros are included as among the UNESCO cluster countries for Eastern Africa. This region is characterised by a rich biological diversity. A range of climatic and geographical characteristics give rise to ecosystems varying from coastal coral reefs to savannah woodlands, and from afro-montane forests to the great Rift Valley with its unique features.



Figure 1: Map of Eastern Africa

(Acknowledgement: *Encarta Encyclopaedia*, Microsoft Corporation, 2009)

The major unifying character of this region is its climate and topography of mountain ranges surrounded and separated by extensive plains which make it one of the most ecologically diverse regions in Africa. Some of the unique mountain ecosystems include mountains like Mt. Kilimanjaro, Mt. Kenya, Mt. Meru, the Ruwenzories and Mt. Elgon

located in the tropics, but occasionally with snow at their tops. There are also many smaller ones which greatly influence the quantity and distribution of the orographic type of rainfall experienced in the region.

2. *Mountain ecosystems in Eastern Africa*

Mt. Kilimanjaro, the highest mountain in Africa, is located in north-eastern Tanzania, near the border with Kenya (Figure 2). Kilimanjaro is a dormant volcano. Its two peaks stand 11 km apart and are connected by a broad ridge. Kibo, which is the higher peak, rises to 5 895 m above sea level. Although Kilimanjaro lies 3° south of the equator, an ice cap covers the crater of Kibo year-round; this ice cap is pierced by several small craters. Kilimanjaro has a number of different vegetation zones on its steep slopes. Coffee and plantains are grown on the lower slopes of Kilimanjaro.

Mount Kenya is an extinct volcano in central Kenya and is located just south of the equator (Figure 3). With an elevation of 5 199 m, Mount Kenya is the second highest mountain in Africa, after Kilimanjaro. Mount Kenya was created by massive, successive eruptions of a volcano 2.5 million to 3 million years ago. Mount Kenya originally had a summit crater, but erosion wore the cone away, leaving a series of snow- and glacier-covered peaks and valleys containing frozen lakes. In the last few years the volcano's glaciers have been losing ground to warmer climate.

Mount Kenya features an array of ecosystems and climatic zones. Grasslands and low trees grow on the basal plateau of the mountain. Rising above the basal plateau, a ring of dense rain forest covers the mountain slopes up to about 3 200 m. Above this rain forest, alpine zone vegetation covers the mountain to about 4 600 m, where it dwindles to mosses and lichens living on the snow-encrusted rocks. From the crowned eagle and mountain buzzard that inhabit the upper mountainous regions, to the elephants, rhinoceroses, forest hogs, and Sykes monkeys that live in the dense forest areas, many animal species gain sustenance from this varied vegetation. For the last ten years, changes in respect to this zonation have been noted. Because climate change occasions longer hot periods than was the case before, most notable change occurs in the alpine zone. Some of the impacts of climate change in the lower zones noted in the last five years has been an increase in forest fires during the prolonged hot dry seasons between the months of January and March.

Mount Elgon is another extinct volcano, on the Kenya-Uganda border. It has an 8 km wide crater, from which rise several peaks. Wagagai is the highest point, with an elevation of 4 321 m. Coffee and bananas are grown on the vast and fertile lower slopes; barren moor lands predominate above about 3 050 m.

Mount Meru is an extinct volcano in north-eastern Tanzania, about 68 km west of Kilimanjaro. After Kilimanjaro, it is the second highest mountain in Tanzania at 4 565 m. Rain forest and bamboo comprise the major vegetation between 1 800 and 2 900 m above sea level, which then gives way to alpine grassland. Volcanic soil and heavy rainfall, especially on the southern and eastern slopes support agriculture. Bananas and coffee are the main crops. By contrast, the north-western and northern slopes of the mountain are barren.



Figure 2: Mt. Kilimanjaro

(Acknowledgement: *Encarta Premium Dictionary 2009*: Redmond, WA: Microsoft Corporation, 2008)



Figure 3: Mt. Kenya with snow on the peaks

(Acknowledgement: *Encarta Premium Dictionary 2009*: Redmond, WA: Microsoft Corporation, 2008)



Figure 4: Ruwenzori Range

(Acknowledgement: *Encarta Premium Dictionary* 2009: Redmond, WA: Microsoft Corporation, 2008.)

The Ruwenzori Range in central Africa forms part of the border between Uganda and the Democratic Republic of the Congo (Figure 4). Margherita Peak, in the southern end of the range, is the highest peak in Uganda, measuring 5 109 m.

On the Ugandan side it forms a plateau declining gradually from 1 300 m in the south to 750 m in the north. The southern portion is a forest zone, although much of it has been cleared for farms. Much of the north is open savannah (grassland with sparse trees and shrubs), though it also contains semi-desert. There are small areas of bamboo and rain forests. The Western Rift of the Great Rift Valley, a series of grabens more than 5 000 km in length along which the Earth's crust is splitting apart, runs through western Uganda. The Ruwenzori Range, on the border with the Democratic Republic of the Congo, contains seven peaks that are covered with snow year-round. The highest is Margherita Peak of Mount Stanley, at 5 109 m tall, the third highest mountain in Africa. Glaciers on Ruwenzori peaks are only 60 km from tropical forests and 100 km from dry savannas. Most of the mountains in East Africa are volcanic in origin, except for the Ruwenzori Range, which was formed by an uplift of Earth's crust as it split along the Western Rift Valley.

3. Eastern Africa as a global hotspot for biodiversity

Africa has been known to be a real centre of globally significant biodiversity. Five out of the world's 25 hotspots for plants (largely forests) are in Africa. One of them is in East Africa, "The Eastern Arc and Coastal Forests of Kenya and Tanzania". The rest are:

West African Rain Forests, Succulent Karoo ecosystems in southern Africa, The Cape Floristic Region in South Africa and Madagascar Island's endemic rich taxa.

Two more sites in eastern Africa are also as important but lack sufficient documentation. These are:

- The Ethiopian Highlands — including dry scrub, forests and heath land;
- The Albertan Rift Forests of Uganda, Burundi and Congo.

In addition, eastern Africa has spectacular herds of large wildlife, the Great Lakes with different groups of endemic fish, the alkaline lakes and wetlands typified by a variety of avifauna. Coral reefs and marine ecosystems of the Indian Ocean abound with a variety of aquatic species. Eastern Africa should be a leader in biodiversity richness but for the threats that face it.

4. The problem

Depletion of biodiversity arising from degradation of the environment in eastern Africa is the source of problems such as soil erosion, water shortage, climate change and poverty. The resultant environmental predicament poses serious challenges to humanity today. Of special concern is the fact that, while much of the Earth's biodiversity is at risk, the risk is highest in most tropical areas which are home to desperately poor people who need to benefit from various development endeavours to meet their livelihood demands. For example, food production in such areas must be intensified to meet the growth in demand due to rising expectations and the rapid increase of populations. Yet agriculture, as traditionally practised, has remained the major cause of destruction of valuable habitats, pushing species towards extinction (McNeely & Scherr 2001).

Some of the major global issues of environmental concern, which are increasingly presenting themselves in eastern Africa, include poverty, deforestation and the impacts of climate change.

4.1 Poverty

Poverty has become a topic of increasing concern. Statistics on poverty especially in the developing countries are frightening. Of the 4.4 billion people living in the developing world:

- 6% have no sanitation;
- 40% live below the poverty line;
- 30% are malnourished; and
- 30% will die before the age of 40.

Most of these problems are evident in eastern Africa and the actual percentages in all the categories continue to rise. There are an ever increasing number of people living in poverty, especially in Sub-Saharan Africa. Many experts link poverty with environmental degradation. The poor people are both agents and victims of environmental degradation. The poor tend to degrade the environment for immediate and short-term gains at the expense of long-term sustainable gains from a conserved environment.

A degraded environment cannot sustain continued use of its natural resources. Poor people often have no option but to use the environment in a non-sustainable manner. These facts together have a large negative synergy, leading to increasing poverty and increased environmental degradation. Thus poverty poses a serious threat to eastern Africa's biodiversity.

A good example in reference to poverty as it relates to environmental degradation, as alluded by Jared Diamond in his publication "How Societies Choose to Fail or Succeed" (Diamond 2005), is that the poor people are both the agents and victims of environmental degradation, which leads to a poverty cycle which the biosphere reserve concept tries to break by linking conservation with development.

4.2 Deforestation

On a global scale, wanton clearing of forests damages the Earth's ability to clean the atmosphere. Tropical rainforests and other large forested regions act as the planet's lungs, converting carbon dioxide back into oxygen and filtering out pollutants. Scientists believe deforestation alters weather patterns and contributes to global warming, accounting for up to 25% of the carbon dioxide released into the atmosphere each year (UNEP 1999).

Each year, an estimated 170 000 square kilometres of rainforest disappear, the equivalent of more than four times the area of Switzerland. Today, rainforests cover less than 8% of the Earth's surface, which is less than half of the area the rainforests covered when they were first exploited (Babin 2004). Consequently, destruction of large areas of rainforest can result in serious environmental problems, loss of habitat, and the extinction of indigenous cultures.

Deforestation in eastern Africa is reaching alarming levels. Tanzania is said to be losing forests at 400 000 hectares per annum. In Kenya, the forest cover now has been reduced to 1.7% instead of the recommended 10%. In Uganda there is increasing pressure to declassify forest reserves to create cultivable land. In the whole region, forests are not regenerating and economic development activities and poverty are eating away most forest reserves.

4.3 Population growth

The major cause of deforestation is population growth and resulting increases in demand for wood products or forest land. Crowded out of existing farm land, many farmers in developing countries in the tropics are forced to clear forest to make way for new plots. To meet their increasing demand for wood and timber for houses, furniture and paper, developed countries have turned to the huge reserves of tropical rainforests. For the rapidly growing populations of eastern Africa, wood remains the primary fuel for cooking and heating.

4.4 Climate change/global warming

Global warming is another negative by-product of air pollution and deforestation and although there is debate about the sources of the problem, most scientists agree that the

Earth is heating up. One of the principal causes is high atmospheric concentrations of gases such as carbon dioxide. These and related greenhouse gases trap heat in the Earth's atmosphere instead of letting it radiate into space, thereby raising air temperature.

Since 1900, atmospheric carbon dioxide levels have risen by 25%, largely due to the burning of fossil fuels and reduction in forest cover which sequesters the carbon. Based on current levels of greenhouse-gas emissions, average temperatures around the globe will increase by 1°C to 3°C (1.8°F to 5.4°F) by the year 2050. Although emission of greenhouse gases has dropped by 11% in recent years, this may be only a temporary lull due to the worldwide recession and industrial slowdowns (IPCC 2000). In fact, it would take a 60% cut in emissions to stabilize atmospheric gases at current levels. The eastern Africa region has not been spared by the climate changes. Amongst the evident impacts are prolonged droughts and changed mountain ecosystems, especially as a result of reduction of the snow that cover the major mountains (Christensen *et al.* 2007).

4.5 *The solution for the threatened biodiversity in East Africa*

In the face of the increasing threat to the eastern Africa biodiversity, is there anything that can be done? Can the battle for biodiversity conservation be won? The answer is Yes, there are still signs of success in conservation of biodiversity in the region, in view of the following facts:

- Protected areas still exist, and they still harbour significant amounts of biodiversity.
- The traditional “protected area” approaches through central control schemes have not totally failed, but they need updating to be more people-friendly and participatory.
- Governments are aware of the importance of community involvement and that conservation has to be a partnership between governments at all levels and local communities.
- New natural resource management policies in the countries in the region are proposing strong empowerment of communities and civil societies in their management.
- Governments in the region are realizing that natural resources valuation is more than direct financial benefits, and that there are deeper economic values behind sustainable natural resource management.
- Global processes such as the Convention on Biological Diversity (CBD) are having an effect albeit slowly, on conservation processes at national and local level.

With the above facts in force, the right tools are needed to push forward the regional biodiversity conservation agenda.

5. *The biosphere reserve concept*

The UNESCO MAB Biosphere Reserve concept is one of the important standard bearers of what may be called the bioregional or, as it has been referred to in the Convention on Biological Diversity, the ecosystem approach. Unlike the “protected area approach”, biosphere reserves are designed from the start to get the local people involved in conserving and managing biodiversity while at the same time meeting their livelihood

needs. This is achieved through sustainable utilization of natural resources in the buffer and transition areas. Thus, biosphere reserves under UNESCO's MAB programme seek to reconcile local communities' economic development with the conservation of biodiversity.

Biosphere reserves are designed to deal with one of the most sensitive and complex questions the world faces today: that is, how to reconcile conservation of biodiversity with development (UNESCO 1996). An effective biosphere reserve involves natural and social scientists, conservation and development groups, management authorities and local communities — all working together to tackle this complex issue (UNESCO 1996). Biosphere reserves provide a framework for sustainable integrated natural resource management and development covering all types of ecosystems' elements including areas of high natural biodiversity, whether conserved or used sustainably, human settlements, and agricultural systems, especially those based on ecosystem management principles. Where transition areas are defined, realistically they will normally include substantial areas of rural landscape.

Biosphere reserves are both concept and tool. Biosphere reserves are defined as areas of terrestrial and aquatic (marine and fresh water) ecosystems, which are internationally recognized through the UNESCO MAB programme (UNESCO 1996). In accordance with the "Statutory Framework of the World Network of Biosphere Reserves", implementation of the biosphere reserve concept was previously guided by the "Seville Strategy for Biosphere Reserves". However, the Madrid Action Plan, which came into force after endorsement by the MAB ICC in Madrid, brought in a special focus considering the emerging global issues of concern, especially the impacts of climate change (UNESCO 2008). Biosphere reserves take shape as part of UNESCO's intergovernmental research programme on Man and the Biosphere (MAB) and they represent a key component in attaining its objective. MAB aims to achieve a sustainable balance between the often conflicting goals of conserving biological diversity and promoting human development while maintaining associated cultural values. Biosphere reserves are sites where this objective is tested, refined, demonstrated and implemented (UNESCO 1996).

The MAB programme is designed to be a strategic programme that explores the relationship of mankind and the environment. The MAB programme has been running since 1971 and has evolved over the years from being purely an ecological and biodiversity science-based programme to one which emphasizes social interaction with the environment. Biosphere reserves are the laboratories and theatres for testing approaches to sustainable development. There are now 580 biosphere reserves around the world in 114 countries (2011). 140 states participate in the wider MAB programme.

5.1 *Research within biosphere reserves*

A major goal of the World Network of Biosphere Reserves is to provide a set of well researched and consistently monitored sites that can act as laboratories/learning sites for further research. The aim is to ensure that conservation, sustainable use of resources, social, cultural and economic development functions are scientifically justified in all the zones of biosphere reserves. This way, biosphere reserves with a good research and

monitoring base would be excellent sites for research on the effectiveness of combining conservation with development.

5.2 Functions of biosphere reserves

Biosphere reserves adopt a threefold functional approach (UNESCO 1996):

- **Conservation** — entails conservation of biological diversity, including preservation of genetic resources, species, ecosystems and landscapes;
- **Development** — entails fostering sustainable economic and human development;
- **Logistical support** — entails establishment and support of demonstration projects, environmental education, training and research, and monitoring related to local, national and global issues of conservation and sustainable development.

5.3 Zoning of biosphere reserves

To sustain the three functions, each biosphere reserve is zoned into core, buffer and transition zones (UNESCO 1996):

- **Core areas** are one or more areas devoted to conservation; they correspond basically to the conservation units (protected areas), designated as areas of complete protection, such as national parks;
- **Buffer zones** are areas surrounding and/or connecting the core areas; their purpose includes the minimization of adverse impacts on the conservation of the core areas and activities must be compatible with the conservation objectives of the biosphere reserve e.g. sustainable use, limited development activities and research;
- **Transition areas** are located outside the buffer zones and do not always have rigidly defined boundaries. They are areas for promoting the improvement of the quality of livelihoods of the local communities, as well as the integration of the reserve with the surrounding urban, agricultural and industrial areas.

5.4 Status of biosphere reserves in Eastern Africa

The distribution of the already declared biosphere reserves in eastern Africa is as follows: Kenya — 6, Madagascar — 3, Tanzania — 3, Uganda — 2, Ethiopia — 2, Rwanda — 1 and Mauritius — 1. They are all functional, and Kenya and Tanzania have conducted periodic reviews of those biosphere reserves declared more than ten years ago.

Most of the countries have not formalized their MAB national committees apart from Ethiopia, Kenya, Tanzania, Rwanda and Madagascar. Ethiopia was commended for having the only MAB committee which is developing a strategic plan of its activities. There is a need for the sub-regional coordinator to do a follow-up of those countries which did not report any MAB activity to establish a national MAB committee and to create awareness of the need to have one.

Implementation of AfriMAB-MAP targets for the region is slow. The process of establishing the Mt. Elgon transboundary biosphere reserve between Kenya and Uganda is reported as being in progress.

Table 1: Biosphere reserve management status in Eastern African countries

Country	Biosphere Reserves (year of designation)	MAB National Committee status/host institution
Kenya	<ul style="list-style-type: none"> • Mt. Kenya BR (1978) • Mt. Kulal BR (1978) • Malindi-Watamu Marine BR (1979) • Kiunga Marine BR (1980) • Amboseli BR (1991) • Mt. Elgon BR (2003) Proposed: <ul style="list-style-type: none"> • Mt. Elgon TBBR • Marsabit BR 	Functional under KNATCO-UNESCO
Tanzania	<ul style="list-style-type: none"> • Lake Manyara BR (1981) • Serengeti-Ngorongoro BR (1981) • East Usambara BR (2000) 	Functional under TEMC
Madagascar	<ul style="list-style-type: none"> • Mananara Nord BR (1990) • Sahamalaza-Iles Radama BR (2001) • Littoral de Toliara BR (2003) 	Functional under PNM-ANGAP/Siege, Direction Interregionale de Toamasina
Ethiopia	<ul style="list-style-type: none"> • Kafa BR (2010) • Yayu BR (2010) Proposed: <ul style="list-style-type: none"> • Lake Tana BR • Shaka Forest BR 	Functional and formalized under Ministry of Science and Technology. National MAB strategic plan in process
Uganda	<ul style="list-style-type: none"> • Queen Elizabeth BR (1979) • Mt. Elgon BR (2005) Proposed: <ul style="list-style-type: none"> • Mt. Elgon TBBR 	Functional under UNATCO-UNESCO
Rwanda	<ul style="list-style-type: none"> • Volcans BR (1983) 	Functional under management of Ministry of Tourism and National Parks
Somalia	N/A	N/A
Mauritius	<ul style="list-style-type: none"> • Macchabee/Bel Ombre BR (1977) 	Functional under National and Conservation Service
Seychelles	N/A	N/A
Comoros	N/A	N/A
Eritrea	N/A	N/A
Djibouti	N/A	N/A

6. Efforts towards implementation of MAP in the sub-region

Implementation of the Madrid Action Plan (MAP) in Africa is coordinated by the AfriMAB regional network secretariat through the national MAB committees. However, most countries have not formerly established functional National MAB committees. The countries that signed AfriMAB charter on the 17th September 2010 during the AfriMAB general assembly in Nairobi (UNESCO 2002b) are nevertheless showing

commitment towards the implementation of the MAP's global main domains which include:

- Domain 1: Cooperation, management, communication;
- Domain 2: Zoning, linking functions to space;
- Domain 3: Science and capacity building; and
- Domain 4: Partnerships.

6.1 Eastern Africa's Action on AfriMAB priority MAP Targets (2010–2013)

Current review of the activities on the priority MAP targets for the period 2010–2013 for AfriMAB indicate that very little has been done in the eastern Africa region towards implementation of the MAP as indicated in the table below.

Table 2: Eastern Africa performance on priority MAP targets for AfriMAB

Target	Actions
Improved financial mechanisms for biosphere reserves and regional networks	Not known
Transboundary Biosphere Reserves	Mt. Elgon (in progress)
Trained biosphere reserve managers and other relevant stakeholders	Planning in process
Integrated information and communication strategy	Scanty
Mitigation in relation to climate change	Little
Exchanges between biosphere reserves	Not much
Biosphere reserves to have research programmes on analyses of ecosystem services and their management through stakeholder participation	Some activity in some of the BRs in Kenya, Tanzania and Uganda
Analysis of zonation of all biosphere reserves	Not done

7. Conclusion

While in the past conservation was too often viewed as a “*closed jar*”, sealing off a natural area from the outside human world, it has been found that such a policy and an outlook to conservation can destroy the area it is intended to protect. Ecological, economic and social pressures — both internal and external — may eventually shatter the area being protected.

The challenge of sustainable natural resource management in eastern Africa countries today is to simultaneously help preserve biological diversity, enhance development and empower poor rural people. As one of the ecosystems management approaches, the biosphere reserve concept is effective in achieving long-term conservation objectives and sustainable development in the same context. Countries of the eastern Africa region should therefore consider designating most of their protected areas as biosphere reserves, especially those which are most likely to be degazetted.

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2



An Evaluation of Conservation Effort in the Bia-Goaso Forest Block

Evaluation des efforts de conservation dans le peuplement forestier de Bia-Goaso

EMMANUEL DANQUAH¹ • WILLIAM ODURO²

Abstract

Wildlife managers often wish to evaluate the effectiveness of conservation effort by measuring trends in wildlife populations and illegal activity. In western Ghana, the Bia-Goaso Forest Block forms a significant portion of forest elephant range in Ghana. We undertook an analysis of poaching activity and elephant population trends in the Bia Biosphere Reserve and Goaso Forest Reserves as a means of evaluating the success or failure of conservation effort in these areas. We used two methods: (a) tracking changes in poaching activity, and (b) monitoring trends in elephant numbers and distribution (core range). Results indicate that the Goaso Forest Reserves seem to be achieving only partial success in protecting elephants, whereas Bia Biosphere Reserve seems to be considerably more effective. In Bia, poaching activity dropped significantly from 0.76 activities per km in 2007 to 0.26 activities per km in 2009 (Mann-Whitney U-test; $U=1634$, $P<0.05$) and core elephant range increased greatly from 45% in 2004 to 78% in 2009. Comparatively, poaching activity in the Goaso area remained high with values ranging between 1.50 activities per km in 2004 to 1.45 activities per km in 2009 whilst core elephant range varied between only 33% and 30%. We attribute these changes to varying conservation and management regimes in Biosphere and Forest Reserves. This calls for renewed efforts to include a more sustainable balance between goals of conserving biological diversity and promoting economic development in the management priorities of the Goaso Forest Reserves based on the Biosphere Reserve concept and programme objectives of UNESCO's Man and the Biosphere (MAB).

Keywords: Bia, Goaso, elephants, poaching, density, biosphere reserve, population, range, core

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Résumé

Les directeurs de parcs naturels souhaitent évaluer l'efficacité des efforts de conservation en mesurant les tendances des populations de la faune et de la flore et les activités illégales. À l'ouest du Ghana, le peuplement forestier de Bia-Goaso représente une portion significative de la population des éléphants de forêt au Ghana. Nous avons mené une étude sur les activités de braconnage et les tendances de la population des éléphants dans la Réserve de biosphère de Bia et les réserves forestières de Goaso en vue d'évaluer le succès ou l'échec des efforts de conservation dans ces zones. Pour ce faire, nous avons utilisé deux méthodes: (a) le repérage des changements dans les activités de braconnage et (b) le suivi des tendances en ce qui concerne les nombres et la répartition des éléphants (population principale). Les résultats indiquent que les Réserves forestières de Goaso semblent ne réaliser qu'un succès partiel dans la protection des éléphants alors que la Réserve de Bia afficherait une efficacité plus optimale. À Bia, les activités de braconnage ont diminué de manière significative, passant de 0,76 activités par km en 2007 à 0,26 activités par km en 2009 (U-Test de Mann-Whitney; $U=1,634$, $P<0,05$) et la population principale d'éléphants a largement augmenté passant de 45 pour cent en 2004 à 78 pour cent en 2009. Comparativement, les activités de braconnage dans la zone de Goaso sont restées élevées, avec des valeurs s'étalant entre 1,50 activités par km en 2004 à 1,45 activités par km en 2009 tandis que la population principale d'éléphants est restée entre 33 et 30 pour cent. Nous attribuons ces changements à divers régimes de conservation et de gestion dans les Réserves de biosphère et forestières. Cet enjeu fait appel à un renouvellement des efforts en vue d'intégrer un équilibre plus durable entre les buts de conservation de la diversité biologique et la promotion du développement économique dans la gestion des priorités concentrées sur la gestion dans les Réserves forestières de Goaso, basée sur le concept de Réserve de biosphère et les objectifs du programme Homme et Biosphère (MAB) de l'UNESCO.

Mots-clés: Bia, Goaso, éléphants, braconnage, densité, réserve de biosphère, population, fourchette, principale

1. Introduction

The distribution of species usually differs between heavily hunted, lightly hunted and un-hunted wildlife habitats (Lopes & Ferrari 2000, Carrillo *et al.* 2000). Consequently, many protected areas including wildlife refuges have been established in many places in order to minimize the negative effects of harmful human activities, including hunting activity and also contribute to the maintenance of natural and cultural values while conserving biological diversity. Protected areas play an important role in the maintenance of wildlife populations, in many cases serving as a source of livelihood support to the human communities living in or adjacent to protected areas (Carrillo *et al.* 2000).

The Ghana High Forest Zone (GHFZ) contributes significantly to protected areas and forest habitats left for most large mammal species in Ghana and is believed to be a major stronghold for forest elephants (Danquah *et al.* 2009a). However, limited areas of

the GHFZ have been extensively surveyed for elephants (PADP 2000, 2001) and information on the population ecology, habitat use and population dynamics of the elephant community are poorly known for this and many other regions of Ghana. The Strategic Environmental Assessment report of the Ghana Poverty Reduction Strategy in 2004 has identified threats from uncontrolled timber and land encroachment, resulting in loss of biodiversity and forest cover, as vital areas of environmental concern and threat to food security in the GHFZ. Therefore, there is a need to monitor elephant populations; in particular, numbers and trends in populations as more and more areas are affected by human activities. It is also necessary to assess whether the management of the constituent protected areas is achieving the objectives set for them (Carrillo *et al.* 2000).

Monitoring plant and animal populations is key to the objectives and core activities of conservation biology (Marsh & Trenham 2007) and has currently taken on great importance as conservationists are presently faced with an increasing struggle to demonstrate progress made towards protecting the earth's biological resources (Stem *et al.* 2005). Conservation biologists recognize that good management goes beyond implementation — effective management is integrally linked to well-designed monitoring and evaluation systems (Stem *et al.* 2005, Margoluis & Salafsky 1998, Woodhill 2000). Monitoring and evaluation is used to assess whether specific management strategies are working and identifies the conditions under which a conservation action is likely to succeed or falter (Hatry 1999, Blann & Light 2000). Moreover, monitoring data are used to track the spread of invasive and pest species (Rooney *et al.* 2004, Marsh & Trenham 2007), identify species which face extinction (Shea & Mangel 2001) and can serve as an early warning system for potential remedial actions to be taken (Hatry 1999, Rigby *et al.* 2000). In essence, monitoring and evaluation forms the basis for improved decision making (Stem *et al.* 2005).

This study provides a substantive analysis of poaching activity and elephant population dynamics in Bia-Goaso Forest Block (BGFB) in Western Ghana as a means of monitoring and evaluating the success or failure of conservation effort in reserves belonging to two protected area management categories (Biosphere and Forest Reserves). These reserves have similar environmental characteristics but different habitat conditions, hunting restrictions and levels of protection. The Bia Biosphere Reserve operates on key components in UNESCO's Man and the Biosphere (MAB) Programme objectives for achieving a sustainable balance between the conflicting goals of conserving biological diversity, promoting economic development and maintaining associated cultural values, whilst the Goaso reserves are managed mainly for timber exploitation. Our objective is to provide a historical review of elephant numbers and poaching activity in the area and relate distribution patterns with trends in poaching activity. The hypothesis was that elephant numbers in the Goaso Forest Reserves would be lower than in the Bia Biosphere Reserve, where hunting is prohibited and there is better natural-resource management. We hope that this review will generate broader discussion and encourage the conservation community to look within and outside its boundaries to identify the most appropriate and effective approaches to measure conservation success under varying conditions.

2. Study area

The study area is located in the Ghana High Forest Zone in Western Ghana and comprises of two focal areas; the Bia Biosphere Reserve and an extensive network of 9 Forest Reserves and 3 Shelterbelts referred to as the Goaso Forest Reserves (Figure 1). The area extends from latitudes 6.15 to 7.20 degrees north and longitudes 2.24 to 3.16 degrees west, south of Sunyani to the west of the Tano River and to the Ghana-Cote d'Ivoire border. The Bia Biosphere Reserve (Bia), formerly Bia Conservation Area, is managed by the Wildlife Division and forms an area of 306 km², whilst the Goaso Forest Reserves (Goaso) totalling approximately 2 600 km², is under the management of the Forestry Division.

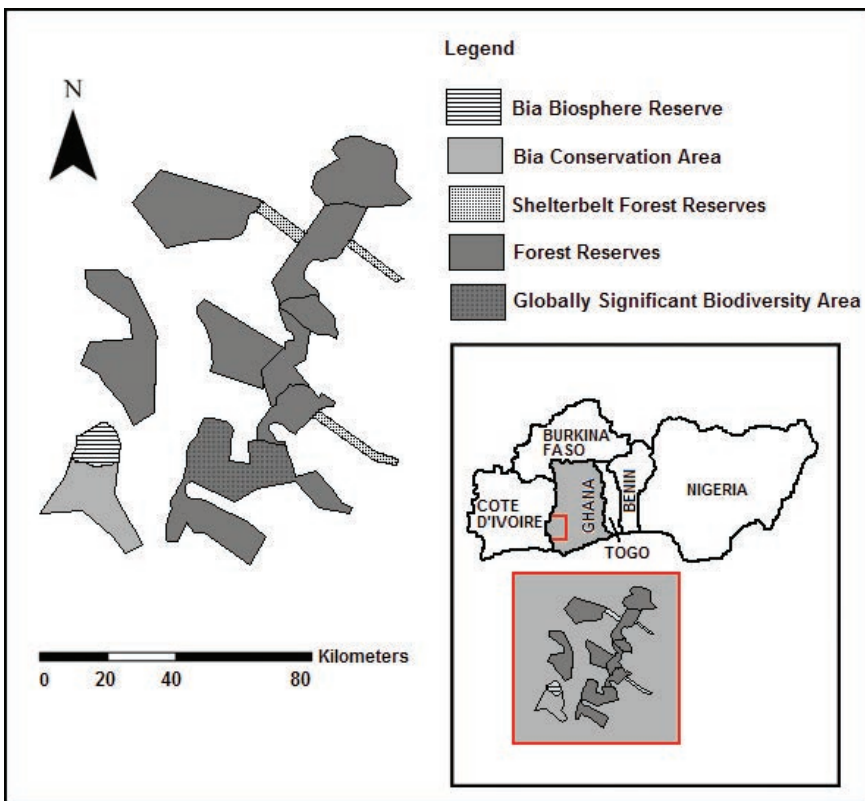


Figure 1: Western Ghana showing the location of Bia Biosphere Reserve and the Goaso Forest Reserves. The inset map shows the location of the study area in Ghana.

The natural land cover of the Western Region corresponds to the Guinea-Congolian forest vegetation (Hawthorne & Musah 1993, Hall & Swaine 1981). At Goaso in the north, the vegetation is dry semi-deciduous; however, more southwards towards Bia, the vegetation changes to the moist semi-deciduous vegetation type (Hall & Swaine 1981). This matches with Taylor's (1960) *Celtis zenkeri*-*Triplochiton scleroxylon* association. Key commercial species of these forests are; *Triplochiton scleroxylon*, *Entandrophragma eutile*,

E. cylindricum with the climbing palms *Ancistrophyllum secundiflorum* and *Calamus deerratus* being characteristic of swampy areas. The mean elevation is 200–550 m, with generally undulating topography. Mean annual rainfall is 680–1450 mm/year, characterized by a bi-modal wet season from March to July and September to November and a major dry season from December to February. High species richness and levels of endemism characterize the area (PADP 2000, 2001, CI 2007).

3. Methods

We reviewed publications (including organizational documents and reports, journal articles, and books) from the field of conservation as part of our overall synthesis of secondary data. We concentrated primarily on elephant research related to the study areas. In addition, we interviewed key informants from different conservation institutions to identify and obtain recommendations on key publications to review.

We analyzed the literature to identify key trends in elephant densities, distribution patterns and poaching activity in the two focal areas over the years. We subsequently concentrated on elephant research that incorporated a combination of elephant abundance data and illegal activity data. Theoretically, an analysis would not vary by whether the data come from scientific or indigenous sources. In reality, however, analyses that rely strictly on indigenous data sources are probably less likely to be formally published. As a result, this analysis focuses on more formal systems.

Elephant distribution in Bia and Goaso for specific survey periods was described using geographic information system (GIS; ArcGIS, version 9.2; ESRI Inc.). Elephant distribution was defined as land cover actively used and occupied by elephants and was scored by means of grid overlay with resolution of 0.25 km². This was expressed as a percentage of each elephant range and was termed Core Elephant Range (CER) of each of these areas. CER was then regressed against poaching activity within each site. An index of poaching activity was derived based on the number of spent gun cartridges, gunshots, hunting camps, wire snares recorded and direct encounters with hunters.

We operated under the implicit assumption that increased conservation effort at Bia, based on its status as a Biosphere Reserve would often lead to better management decisions and therefore improved trends in elephant abundance patterns and reduced poaching activity compared to Goaso. However, it was beyond the scope of this research to assess how successfully different conservation programmes have been implemented and whether they have resulted in improved conservation.

4. Results

4.1 Review of elephant estimates

4.1.1 Bia Biosphere Reserve

In western Ghana, Bia has received the most attention in terms of elephant surveys. In a first study based on track identification, Sikes (1975) estimated 52 to 82 elephants (Table 1), giving a density of 0.25 per km².

Table I: Sequential elephant estimates for Bia and Goaso from 1975 to 2009

Source	Estimation Model	Year	Elephant Estimate / Range	
			Bia	Goaso
Sikes (1975)		1975	67	
Range			52–82	
Martin (1982)		1982	101	
Range			89–113	
Short (1983)		1983	88	
Range			40–135	
Dickinson (1990)		1990		225
Range				200–250
Heffernan and Graham (2000)		1999	137	
Sam (2000)		2000	127	
Sam <i>et al.</i> (2006)	Rainfall Model	2004	115	57
Sam <i>et al.</i> (2006)	Steady State Assumption	2004	146	72
	Merged Estimate	2004	126	65
Danquah <i>et al.</i> (2009a)	Wet Season	2007	133	90
Danquah <i>et al.</i> (2009a)	Dry Season	2007	137	83
	Merged Estimate	2007	135	87
Danquah <i>et al.</i> (2007)	Rainfall Model	2007	133	
Danquah <i>et al.</i> (2007)	Steady State Assumption	2007	128	
	Merged Estimate	2007	131	
Danquah <i>et al.</i> (2009b)	Rainfall Model	2009	139	
Danquah <i>et al.</i> (2009b)	Steady State Assumption	2009	133	
	Merged Estimate	2009	136	

Martin (1982) followed with an estimate of between 200 to 250 for the Bia cluster of forests (originally 1500 km² including the now degraded Bia Tawya and Sukusuku FRs). Based on his elephant densities, he provided an estimate of between 89 and 113 elephants (0.29–0.37 per km²) for Bia. This compared well with the estimated density of 0.33 per km² (40 to 135 elephants) presented by Short (1983). Heffernan and Graham (2000) later estimated 137 elephants (0.45 per km²), which was shortly followed by 127 elephants (0.42 per km²) provided by Sam (2000).

Later in 2004, Sam *et al.* (2006) conducted a line transect elephant survey in the Bia-Goaso Forest Block. They used two estimation models (Rainfall and Steady State Assumption) to generate two different estimates for Bia. These estimates were merged (Norton-Griffiths 1978) which gave 126 elephants (0.41 per km²). Soon afterwards, in 2007, Danquah *et al.* (2009a) under the auspices of A Rocha Ghana conducted a retrospective elephant survey in the same area. Their merged estimate in both the dry and wet seasons was 135 elephants (0.44 per km²) for Bia. Danquah *et al.* (2007) in the *Protected Areas Development Programme Phase II (PADP II)* project again provided two estimates for Bia in 2007 but this time based on the Rainfall and Steady State Assumption Models.

The merged estimate from the two estimation models was 131 elephants (0.43 per km²). PADP II repeated the survey in 2009 (Danquah *et al.* 2009b), which resulted in a merged estimate of 136 elephants (0.44 per km²).

4.1.2 Goaso Forest Reserves

Pre-1995 densities indicate between 200–250 elephants (Dickinson 1990). A decade later, in 2004, Sam *et al.* (2006) produced a merged estimate of 65 elephants (0.09 per km²) for the northern half (Mpameso area; 700 km²) of Goaso. Shortly in 2007, Danquah *et al.* (2009a) also provided a merged estimate (dry and wet season) of 87 elephants (0.12 per km²). Both Sam *et al.* (2006) and Danquah *et al.* (2009a) did not record any elephant activity in the southern half of Goaso.

4.2 Elephant population trends

General historical trends in elephant numbers suggest an increasing density in Bia (Figure 2). Though insufficient data exist for Goaso, available data suggest a rather decreasing elephant population.

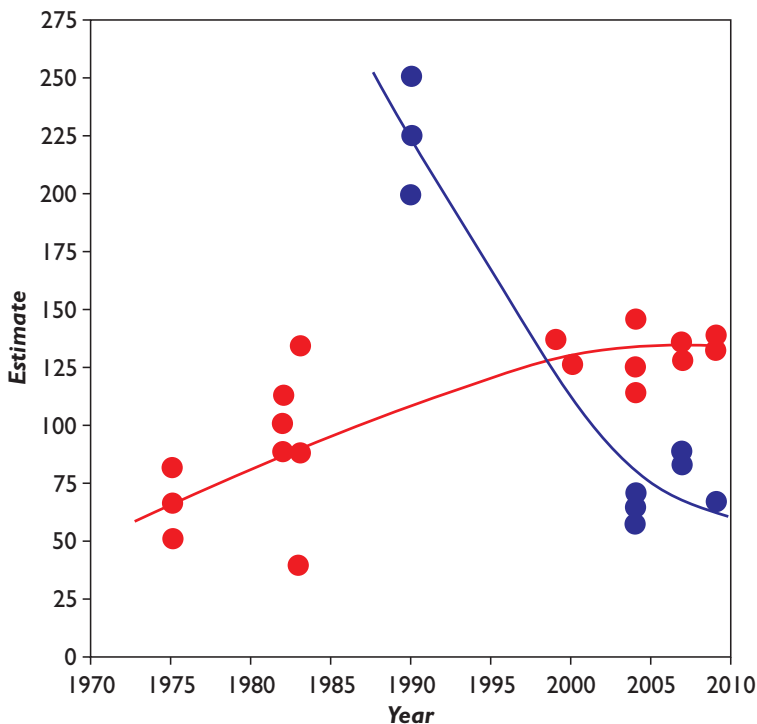


Figure 2: Elephant population trends for Bia (red) and Goaso area (blue) from 1975–2009

4.3 *Elephant distribution and poaching activity*

4.3.1 Bia Biosphere Reserve

According to Martin (1982) and Short (1983), elephants were originally found throughout Bia. However, the creation of dams and secondary vegetation conditions in Bia Biosphere Reserve (BR) as a result of logging activities in the early 1980s begun to skew elephant distribution into the Bia BR (De Leede 1994, Barnes 1996, Sam 2000, Heffernan & Graham 2000). Conversion of the Sukusuku and Bia Tawya FRs in southern Bia to cocoa farms might have further attracted elephants southwards (Martin 1982). Relatively higher poaching activity in the Bia National Park (NP) compared to Bia BR (Sam 2000, Sam *et al.* 2006, Danquah *et al.* 2007, 2009a) might have also contributed to this type of distribution. In 2004, CER was 45% of Bia whilst mean poaching activity was at 0.74 activities per km (Sam *et al.* 2006).

Records of elephant activity since 2004 show a gradual northward spread of elephant density back into the Bia NP (Danquah *et al.* 2007, 2009a). By 2007, CER had increased to 58% whilst poaching activity more or less stabilized at a mean rate of 0.76 activities per km.

By 2009, poaching activity was much reduced (0.26 activities per km) and elephant range had greatly extended (78%) to the northern limits of Bia (Danquah *et al.* 2009b). This reduction is significant (Mann-Whitney U-test; $U=1634$, $P<0.05$). The number of poaching indices (snail harvesting, wire snares, spent cartridges, carbide spots and poacher camps) declined to mostly snail harvesting and hunting with wire snares from 2007 to 2009.

4.3.2 Goaso Forest Reserves

Originally, the largest forest elephant population in the region was confined to the Goaso forests. Pre-1995 and early post-1995 densities indicate a very widespread elephant distribution (Dickinson 1990, De Leede 1994, Parren *et al.* 2002). By 1999, Wildlife Division staff and farmers reported regular to frequent crop raiding cases in seven of nine forest reserves (78%) in the Goaso area and there was regular elephant movement between the reserves (Parren *et al.* 2002, Parren & Sam 2003).

By 2003, only five northern reserves (Mpameso, Bia Tano, Bia North, Asukese and Bonkoni FRs) showed some signs of elephant presence (BP Conservation Awards 2003). There was no sign of elephant movement between reserves except from Mpameso to Bia Tano through the Bia Shelterbelt. Sam *et al.* (2006) estimated CER in 2004 as 33% of the Goaso area and a mean encounter rate of 1.50 per km. Poaching activity was highest (1.52 poaching activities per km) in the southern reserves compared to the northern reserves (1.48 poaching activities per km).

In 2007, Danquah *et al.* (2009a) observed that elephants were patchily confined to the Mpameso area of the Goaso Forest Block. Poaching activity was generally higher than in 2004 (encounter rate: northern reserves = 1.73 per km; southern reserves = 1.71 per km; mean encounter rate: 1.72 per km) and CER had decreased to 27% of the Goaso area. Current poaching activity is slightly lower than in 2007 (encounter rate: northern

reserves = 1.42 per km; southern reserves = 1.48 per km; mean encounter rate: 1.45 per km) and CER is 30% of the Goaso reserves.

4.4 Relation between elephant distribution and poaching activity in western Ghana

Generally, poaching activity impacted negatively on core area utilized by elephants in BGFB in western Ghana (Figure 3).

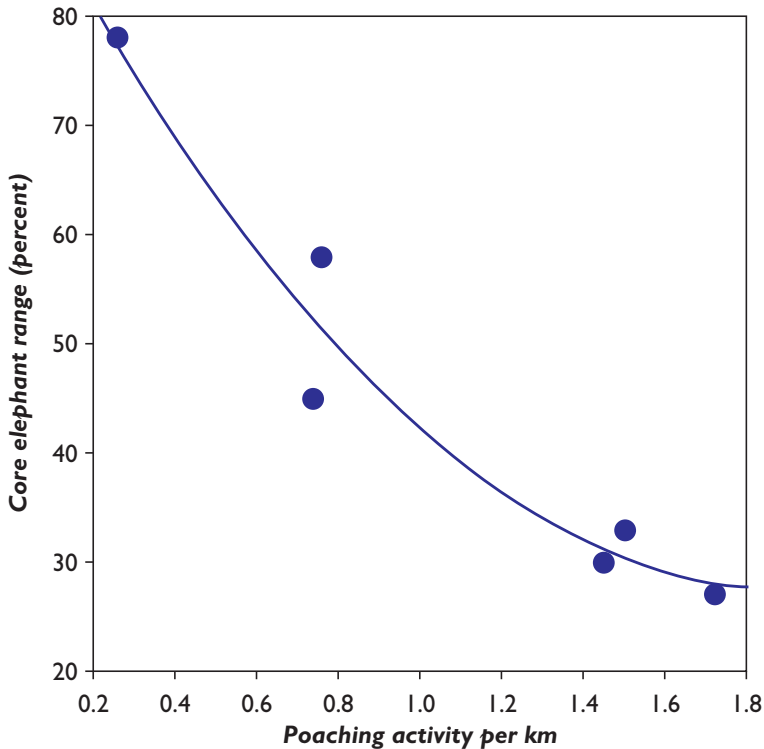


Figure 3: Relationship between poaching activity and CER for six survey periods (three each in Bia and Goaso) in western Ghana

5. Discussion

It is difficult to make realistic density comparisons between Bia and the Goaso area for elephants because different sampling methods were used. A particular problem is the different sampling survey periods and sampling objectives. Nevertheless, we are motivated by the apparent trends revealed. It appears that there has been a general increase in elephant numbers and core range in Bia and that the elephant population might have more than doubled over the years from 1975 to 1999. During the past decade elephant numbers may have more or less stabilized. Even so, the number of elephants known to have been killed recently is not certain and may represent a small percentage of

the population, and there is no other evidence to indicate that the population is not increasing or, worse still, have declined. The Bia elephant population in terms of its size, seems a more viable population compared to the Goaso population, and with sustained wildlife protection, the Bia population has a good chance of survival in the long term.

Many reports describe the simultaneous increase in elephant density in Bia (Sam *et al.* 2006, Danquah *et al.* 2007, 2009a, 2009b), hence, the pattern cannot just be attributed to random elephant movements or short-term (within year) variation in rainfall. Several factors may have favoured the persistence of elephants in Bia over the past few decades. One is the status of protection of the reserve. Bia is a fully protected area and also a Biosphere Reserve; hence it operates on the objectives of UNESCO's Man and the Biosphere (MAB) Programme and wildlife protection is enforced by the Ghana Wildlife Division. Secondly, Bia has benefitted from several conservation-oriented projects. Notable projects include the just-ended European Union funded *Protected Areas Development Programme Phase II* (PADP II) in 2009, under which research and law enforcement were increased and more patrol staff were trained and equipped with improved monitoring and research techniques. Major reductions in mean poaching encounter rates in Bia and associated significant increases in the core elephant range occurred under the project lifespan from the year 2007 to 2009 (Danquah *et al.* 2007, 2009a, 2009b). Hence, the elephant population seems to have recovered significantly through improved and regularly applied wildlife management strategies or new guard strategies devised by wildlife patrol teams. The fact that elephants in general have increased in range may also arise from the need to decrease competition because of increasing densities. Again, changes in elephant abundance and distribution since 2007 could also result from changing hunting patterns by poachers (e.g. hunting with firearms getting replaced by trapping of small prey).

The Goaso range of reserves on the other hand is managed by the Ghana Forestry Division, which does not focus on conserving wildlife. Most of the management priorities are directed at sustaining logging regimes. The area has also not benefitted from any major wildlife conservation-related project. Moreover, more than a decade of excessive commercial hunting in the 1990s has severely reduced the population of elephants including several large specimens. Recent confirmed reports (Sam *et al.* 2006, Danquah *et al.* 2009b), as well as observations by naturalists and WD staff, give substantial indications that there have been massive declines in both elephant numbers and range, especially over the past decade, primarily as a result of illegal hunting for ivory. Reports from the field indicate that elephant poaching in the area is fuelled by professional elephant hunters from nearby Cote d'Ivoire who easily transport ivory across the borders. The abundance of mammal species has generally been shown to vary considerably between reserves and several mammal species have not been reliably observed in certain areas for several years (Danquah *et al.* 2009a, 2009b). This could particularly be the case for other large mammal species such as buffalos, bongos, leopards and chimpanzees and this is suspected to reflect population changes, resulting from high hunting pressure.

However, the principal threat in the Goaso area which could have led the transition of elephants from highly abundant animals to their generally threatened and vulnerable status is loss of range and habitat as result of rapidly increasing human populations.

The beginning of the year 1990 witnessed a period of massive acceleration of migrants, mainly farmers from other regions in Ghana to the high forest zone in western Ghana (Sam 2000). The boom in Ghana's timber and cocoa industry in the 1990s exacerbated the situation and contributed to severe encroachment on elephant habitat with major recorded decreases in effective elephant range and numbers. For the period, forests cover decreased by 4.53%. The rate of forest loss was estimated to be 326.23 ha per annum. The size of the degraded or open area has increased by 18.95%. Current satellite images combined with ground investigations indicate few forests remaining outside the reserves where much of the original vegetation has been converted for agricultural purposes and for urban expansion. Currently, many villages and hamlets also lay scattered through the whole area.

We classify elephants currently as uncommon in the Goaso area and have assessed trends to be decreasing. The significant number of low density reserves compared to past levels of abundance suggests an elephant population in danger. Interviews with conservation managers and local hunters suggest that elephant density and core range in the Goaso area continue to decline. With improvement in management and wildlife protection, the Goaso population has a good chance of survival, simply because the area is bigger and reserves are already networked.

6. Conclusions

The Goaso Forest Reserves seem to be achieving only partial success in protecting elephants, whereas Bia Biosphere Reserve seems to be considerably more effective. Compared to Goaso, elephant numbers and range are significantly higher and increasing in Bia, confirming our hypothesis of higher elephant numbers in Biosphere Reserves than in Forest Reserves.

The level of law enforcement and poaching activity is directly affecting core elephant range. Hence, the study documents a case in which conservation effort in a reserve (category of protected area) clearly has an effect on the resident elephant population (Carrillo *et al.* 2000).

7. Taking action

Based on these general lessons, it is possible to identify at least three immediate areas for action in the high forest zone of western Ghana. First, it is clearly necessary to establish a more concerted effort involving more stakeholders for monitoring elephant trends and habitat variables on the long-term in the Goaso area. There is a need for greater collaboration among the government and the conservation community to work collectively and support the Biosphere Reserve concept in the forest reserves. More specifically, it is important for conservation practitioners to agree on the key steps and guiding principles for reconciling the conservation of biodiversity, the quest for economic and social development and maintenance of associated cultural values, particularly for the Goaso area — a domain where UNESCO's Man and the Biosphere (MAB) Programme has already made considerable progress. In developing and implementing

standards, however, it is important not to be sidetracked by nuances inherent in differing approaches (e.g. terminology and ordering of steps), but rather to agree more generally on common steps, underlying principles, and guidelines. Which specific approach an organization uses is less important than its adherence to these underlying principles and guidelines. Likewise, the conservation community would benefit from greater agreement on “short lists” of potential indicators for common conservation targets or values and more strategic selection of programmatic indicators of success. Programmatic indicators, however, should not be drawn from the laundry-list efforts of the past. Instead, these indicators should be the result of a process to identify measures that clearly relate to programmatic goals, objectives, and activities and that show progress along a causal chain toward the desired conservation state.

Secondly, the conservation and restoration of degraded forests should be a priority for stabilizing and maintaining existing healthy elephant populations. A variety of economic instruments, including carbon financing and payments for environmental services (PES), can be used to encourage farmers to restore and conserve forests, retain tree cover and adopt biodiversity-friendly cropping systems. PES holds particular promise. Although PES schemes appear to be successful in conserving forest cover in different parts of the world, they could have a greater positive impact on rural landscapes and livelihoods if they included payments for a greater diversity of sustainable land uses, removed inappropriate access restrictions (such as minimum land size), lowered transaction costs, and carefully targeted priority landscapes that have the greatest potential to conserve both biodiversity and rural livelihoods (Grieg-Gran *et al.* 2005, Pagiola *et al.* 2005).

Finally, despite the lack of extensive experimental evidence, more management activities aimed at decreasing poaching activity and increasing the quantity and quality of both refuge and food should be implemented. Enforcement of hunting restrictions in the forest reserves is difficult, perhaps unrealistic, and even socially undesirable, as long as the current socioeconomic conditions persist. Yet overexploitation must be avoided so that many other large animals do not become extinct in the region; hunting should be sustainable. This goal can be reached, however, only if we have basic information about the populations of most other wildlife in the area so that changes in their abundance and the effects of disturbance and management can be assessed. Standardization of methods to undertake these assessments in tropical forests is of foremost importance. It is also necessary to work with the communities that live in and around protected areas: if their standards of living improve, then pressure on wildlife populations will be minimized (Carrillo *et al.* 2000).

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3



Zonation and the Sustainable Management of Natural Resources: the Case of the Transboundary Biosphere Reserve (TBR) W Park (Benin, Burkina Faso, Niger)

Zonage et gestion durable des ressources naturelles: cas de la Réserve de Biosphère Transfrontière (RBT) du W (Bénin, Burkina Faso, Niger)

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Abstract

The W Transboundary Biosphere Reserve, a natural park with multiple types and issues, is considered to be the largest natural transboundary ecosystem in West Africa and constitutes, since 2002, a pilot experiment within the context of resource preservation and the integration of the resident populations in the three countries Benin, Burkina Faso and Niger. The experiment shows the wish of these countries' authorities to list the entire W Park as a transboundary biosphere reserve (TBR). UNESCO's Man and Biosphere Programme (MAB) and other partners share these countries' view.

The TBR W has a long conservation history spanning from the colonial era to modern day. The zonation as a biosphere reserve makes it possible to promote sustainable transboundary management in order to help reduce poverty in the three countries' resident populations.

The region is characterized by (i) great natural and agricultural potential, (ii) a changing environment as a result of strong migratory pressure, and (iii) the development of production systems and the degradation of natural resources. Analysis of

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the biodiversity's evolution indicates that (i) the forest ecosystems are overall in a good state of conservation, (ii) several vegetation types offer significant potential for ensuring the preservation of biodiversity, (iii) apart from a number of lists, flora and fauna diversity remains little-known at a quantitative and qualitative level and in terms of the connections that govern the elements between them, (iv) the degradation trends are noticeable despite the consented efforts of the region's various projects.

Preliminary investigations into the protected areas have revealed that bush fires and excessive logging constitute the main causes of vegetation degradation, while stock farming and agriculture are in third and second place, respectively. The biosphere reserve management plan, should it be successful, could be used as a model for the sustainable use of natural resources within the context of sustainable local development, and it would also serve as an integration indicator as advocated by the Economic Community Of West African States (ECOWAS).

Key words: Transboundary biosphere reserve, W Park, biodiversity conservation, zonation, West Africa.

Résumé

La réserve de biosphère transfrontalière du W, parc naturel aux multiples faciès et enjeux, considérée comme le plus grand écosystème naturel transfrontalier en Afrique de l'Ouest, constitue depuis 2002 une expérience pilote expérimentant dans le cadre de la préservation des ressources et l'intégration des populations riveraines de trois pays Bénin, Burkina Faso et Niger. Elle représente une volonté des autorités de ces pays pour inscrire l'ensemble du Parc W dans le cadre d'une réserve de biosphère transfrontière (RBT). Le programme l'Homme et la Biosphère (MAB) de l'UNESCO et d'autres partenaires accompagnent le Burkina Faso, le Niger et le Bénin.

La RBT du W a une longue histoire de conservation depuis la période coloniale à nos jours. Le zonage dans le cadre d'une réserve de biosphère, permet de promouvoir une gestion durable transfrontière afin de contribuer à la réduction de la pauvreté au niveau des populations riveraines de trois pays.

La région est caractérisée par (i) les énormes potentialités naturelles et agricoles, (ii) l'environnement en mutation dû à une forte pression migratoire, (iii) l'évolution des systèmes de production et la dégradation des ressources naturelles. L'analyse de l'évolution de la biodiversité biologique indique que (i) les écosystèmes forestiers sont dans l'ensemble en bon état de conservation, (ii) plusieurs faciès de végétation offrent de réelles potentialités pour assurer la préservation de la diversité biologique, (iii) la diversité floristique et faunique, malgré quelques inventaires, demeure méconnue sur les plans qualitatifs, quantitatifs et des liens qui régissent les éléments entre eux, (iv) les tendances de dégradations sont perceptibles malgré des efforts consentis par les différents Projets dans la région.

Les enquêtes préliminaires sur les aires protégées ont révélé que les feux de brousse et la coupe abusive du bois constituent les principales causes de dégradation

de la végétation, l'élevage et l'agriculture occupant respectivement le troisième et le quatrième rang. Le plan de gestion des réserves de biosphères, s'il réussissait, servirait de modèle d'utilisation durable des ressources naturelles dans le cadre du développement local durable, il serait aussi un indicateur d'intégration tel que prôné par la Communauté des Etats de l'Afrique de l'Ouest (CEDEAO).

Mots clés: Réserve de biosphère transfrontière, Parc du W, zonage, Biodiversité, Conservation, Afrique de l'Ouest.

I. Introduction

Long ago, when Africa's population was still relatively sparse, there was little degradation of natural resources; but then came the demographic upsurge of the past few decades. In 1960, the year numerous countries gained independence, the African continent had a population of 273 million inhabitants, and in 1980 it had 460 million (Déjoux 1988). Recent statistics established by the United Nations show that in the year 2000 Africa had between 768 and 864 million inhabitants. This rapid demographical expansion was accompanied by an increase in the use of the natural environment, intense urbanisation and an ever-increasing and changing economy.

Closer to us, in Sahelo-Sudanese Africa, the latitudinal displacement of the isohyets over the last forty years has led to an increasingly intense desertification and over-utilisation of natural resources, which threatens the protected areas. Environmental degradation is therefore not a new phenomenon in Africa; it occurs when natural resources are used up by human activity. However, while they were formerly localised, the pressures currently experienced by Africa's natural resources are threatening its entire ecological balance. It is evident that drought and environmental degradation complement one another and could become irreversible. Faced with this almost global situation, UNESCO's biosphere reserves are, according to the Seville Strategy (1996), the answer to one of the world's most critical questions today: how do we reconcile biodiversity and bio-resource conservation and their sustainable use?

Sustainable resource management currently seems to be the mobilising theme for apprehending the wide variety of environmental management issues with which we are faced. Since the first Biosphere Reserve Congress held in Minsk (Belarus) in 1983 to the second congress in Seville (Spain), to the 4th World Congress on National Parks and Protected Areas held in Caracas (Venezuela), in February 1992, important innovations were made in biosphere reserve management. New methodologies were developed for enabling all partners to get involved in the decision making and conflict resolution process, and more attention was focused on the necessity of using regional approaches. New forms of biosphere reserves, such as transboundary reserves, were developed. It has since become possible to tackle the challenges related to biosphere reserve management from a cross-border angle, on a local as well as on a global scale.

This article broaches one of the challenges in the zonation of the W Park as a tool for the joint and sustainable management of natural resources between the three neighbour countries (Benin, Burkina Faso and Niger). The article is a bibliographical review of various authors' works, and focuses on the reality of the W Transboundary Biosphere Reserve with regard to zonation.

2. *The inter-state conservation location of the W Park*

West African francophone countries such as Benin, Burkina Faso and Niger have several protected areas which were mostly listed during the colonial period. The W Park, which extends over the northern parts of Benin, eastern Burkina Faso and southern Niger, is a particular case due to its inter-state and bio-geographical location.

Since 1926, when the area was identified as a zone of refuge, W National Park constituted, according to the colonial administration based in Dakar, an entity in accordance with French legislation and regulations in the colonies. The zone as a whole had a sparse human population and harbours a rich biodiversity. These assets won the area its listing as a total wildlife reserve through Decree no. 2606 S.E./F of 14 April 1953 and as a national park on 4 August 1954. The administrative and forest services were in charge of the coherence of its management at the federal level. After the countries' proclamation of independence, this regional centralised management (with a single administrative manager) gave way to a national sectional management (with managers from each country). Similar statutory conservation texts also exist in the two other components of the park in Niger and Benin.

The introduction of a cross-border collaboration arose from a joint initiative between Benin and Burkina Faso who had, on either side of their shared border, the group of parks and hunting areas that make up W National Park shared by Niger, Burkina Faso and Benin, the Kourtiagou, Arly, Pama and Madjaori reserves in Burkina Faso and the national park and hunting areas of the Pendjari and Atakora in Benin. This initiative was formalised on 12 July 1984 by the signing of an agreement for the fight against poaching to which Niger adhered to in 1986, and which came into effect on 1 January 1986. By their declaration on 12 May 2000 in Tapoa (Niger), the ministers in charge of the protected areas in Benin, Burkina Faso and Niger expressed their wish to list the components of the W Park in Benin and Burkina Faso and the Arly Park in Burkina Faso in the international biosphere reserve network of UNESCO's MAB programme. Following this declaration, and with the support of the Protected Ecosystems in Soudano-Sahelian Africa project (ECOPASS — *Ecosystème Protégé de l'Afrique Soudanienne et Sahélienne*) and the National Centre for Scientific and Technological Research, the MAB's national committee and Burkina Faso's national coordination of the ECOPASS project collaborated in the drawing-up of two biosphere reserve proposals for the Arly Park and the W Park in Burkina Faso.

Burkina's W Park proposal, much like those of Benin and Niger, was examined during the Ougarou regional meeting on 29 and 30 May 2001, with experts from Benin, Burkina Faso, Niger, and UNESCO, in order to harmonise a single transboundary

biosphere reserve proposal, uniting the three countries' components of the park. It was at this meeting that the idea came up for a proposal for the Arly Park as a biosphere reserve in order to consider creating the Arly –Pendjari Transboundary Biosphere Reserve together with Benin's Pendjari Biosphere Reserve. Subsequently, Burkina's two proposals (W and Arly) were examined during the national biosphere reserve workshop held on 20 and 21 November 2001 in Ouagadougou (Burkina Faso), at the MAB/UNESCO programme's third birthday.

This political wish accompanied by the people's adherence has made it possible to list the two national components of Benin's and Burkina Faso's W Park in the international network of biosphere reserves along with Niger's part which had already been listed, making the entire W Park one of the very first transboundary biosphere reserves (TBR) in Africa shared by three countries (Benin, Burkina Faso and Niger).

3. The W site: providing a biological heritage and ecosystems zonation system

The W Transboundary Biosphere Reserve (TBR) is one component of a cross-border ecosystem straddling the three countries Benin, Burkina Faso and Niger. It has a Sudanese climate in the North and East of the conservation zone and a Sudano-Guinean climate in the area's southern and western regions, with two highly contrasting seasons: a rainy season concentrated in the months of June to September, alternating with a dry season lasting 5 to 8 months, depending on the zones. Degradation in the climatic conditions has been observed for many years. Albergel *et al.* (1984), quoted by Bonkougou (1985), have shown that the decennial rainfall averages since 1920 have undergone a southward latitudinal displacement. This climatic degradation results in the intensification of southward migrations and significant population densities around W Park (Map 2) which have caused intense anthropogenic pressures on the natural resources as the production systems of food-producing crops have not evolved towards an intensive form of land use. On the whole, they remained non-intensive, and land shortage has led to the shortening of fallow periods, compromising the natural soil fertility regeneration process. The combined effects of climatic condition degradation and inappropriate land management (intensive agriculture, overgrazing, bush fires, etc.) has not only led to serious desertification problems but also to an overall underdevelopment and increase in poverty in rural areas.

The region is characterised by four major phenomena which put the issue of zonation for uniting conservation and local development supported by applied research (Anonymous 1996, Poda 2004) on centre stage: (i) a population of close to 500 000 inhabitants in the biosphere reserve's resident villages, with a high growth rate, (ii) an active agricultural front, marked by cash crops which account for early land saturation, (iii) a strong pressure due to pastoralism and transhumance, and (iv) the populations' dependence on the protected areas' natural resources, which is estimated at 80% of their needs, and is disparate in the three countries. In these conditions, conservation takes on a cross-border character, and its viability has to take into account the needs

of the poverty-stricken resident populations (Proceedings of the tripartite meetings of Kompienga and Tapoa).

The zone can be used in a concerted manner for the *in situ* conservation of genetic resources (flora and fauna) of rare, endemic and endangered species. The area can also be used for the rehabilitation and reintroduction of endangered or extinct multi-purpose plant species. One of the proposed biosphere reserve's major assets is its large variety of habitats extending from the plateau sandstone plates to the smooth bodies of water of the main rivers and streams. The relief establishes diversified landscapes which constitute the region's tourist attractions.

Seven main types of habitat can be distinguished:

- wetlands (ponds, streams, rivers) with aquatic grasslands;
- gallery forests;
- forest formations (dry woodlands);
- wooded and shrubby formations;
- grassy herbaceous formations;
- anthropogenic formations (fallow land, abandoned farmland, ancient ruins);
- the "bowé".

3.1 Flora diversity

The W Biosphere Reserve is of the "dry tropical forest" type and corresponds to the Sudanese domain. Description of the flora is still imprecise, despite several lists which cover the three parts of the park simultaneously. The information available on woody plants is fragmentary and there is no collected data on grasses. The ecosystems are composed of 72% shrubby savannah, 14% wooded savannah, 12% grassy savannah and 2% high altitude vegetation (Guinko 1984). In the areas bordering on villages, the rate of agricultural encroachment stands at a manageable level of 1.5%.

3.2 Fauna diversity

The fauna is the area's main asset, but knowledge thereof remains sketchy. The area's only permanent watercourse is the Pendjari River which shares its fish species with the Arly and Pendjari. The list of fish species included in the dossier shows the available data with regard to conservation units and is supplemented by the results of works completed at various times. As far as avifauna is concerned, the listing is far from complete. Avifauna can be estimated to be relatively abundant. Large fauna, which attracts tourists, consists of approximately 20 species including three primates, three large carnivores (lion, leopard and cheetah), thirteen ungulates such as hippopotamus, buffalo and elephant, which are relatively easy to observe. The various works indicate the density of certain species, showing a predominance of buffalo, sable antelope, hartebeest, warthog, waterbuck and duiker. The information available indicates very low densities of species adapted to riparian formations, including bushbuck, reedbuck and waterbuck. Small fauna is relatively abundant.

3.3 Key points

Analysis of the biodiversity's evolution indicates that:

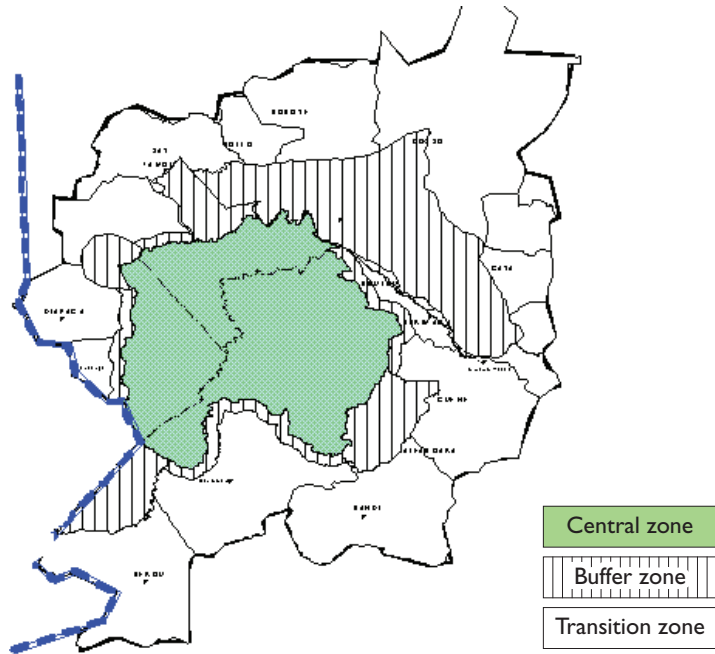
- the forest ecosystems are, on the whole, in a good state of conservation,
- several vegetation types offer significant potential for ensuring the preservation of biodiversity,
- despite certain lists, flora and fauna diversity remains little-known in terms of quality and quantity and the connections that govern the elements between them,
- degradation trends are noticeable despite all the role players' efforts.

4. *The zonation of W Park: a cross-border cooperation tool*

The management systems used by the colonial administration in the 1950s and the 1960s are almost the same, focussing on prohibitions on forest hunting, police operations, the fight against illegal removal, and ecosystem development, while favouring development through tourism. The need for collaboration, consultation and cooperation was hampered by the lack of a communication and concerted decision making system, by institutional and organisational weaknesses and the lack of a trans-border management approach in the national environmental policies. In the light of the national management's existing limits, the orientation was defined within the framework of ECOPASS, a regional programme financed by the European Union. This great opportunity allowed for cross-border zonation, as the regional zonation approach added value compared to the national management in terms of protected area conservation and the sustainable use of natural resources.

The zonation proposal is based on the conservation needs of the fauna (large and small, land and water), the ecosystems and the realities of the socio-economic development underway (GRAD 2004, SECA & BERLI 2003). The consensual zonation was defined in 2001 during the regional workshop in Ougarou (Burkina Faso) between the political persons in charge and experts, including the three countries' MAB committees and the UNESCO Paris representative. The zonation is presented as follows (Map 1):

The central area comprises the countries' three national park areas forming W Park: (i) Benin's W National Park, classified by Decree 6009 /S/ET of 4 August 1954, with an area of 5 020 km², (ii) Burkina Faso's W National Park, first classified by Decree no. 2606/SE/F of 14 April 1953 as a total wildlife reserve and established as a national park within its current boundaries by the decree of 4 August 1954, with an area of 2 350 km², and (iii) Niger's W National Park, classified by Decree 6009 /S/ET of 4 August 1954 with an area of 2 200 km². The central transboundary area thus formed takes into account all the ecosystem types, including the border watercourse Pendjari. By virtue of the zone's classification status, the entire central area is protected, without any permanent human settlements inside its boundaries. The central zone participates in functions relating to conservation, ecological monitoring and scientific research.



Map I

The buffer zone includes the hunting zones or sport hunting concessions adjacent to W Transboundary National Park. It is made up of (i) Benin’s three hunting zones of the Pendjari (1 800 km²), the Atakora (1 750 km²) and the Djona (1 150 km²), the first zone having been established in 1961 and the second and third zones in 1959, (ii) Burkina Faso’s partial wildlife reserve of the Kourtiagou or Kondio (510 km²), the Tapoa Djerma hunting areas (300 km²) and the Koakrana hunting area (300 km²), the legal texts governing the buffer zone’s areas being Decree no. 1615 of 5 April 1957 which delimits the area and defines the regulations of the partial wildlife reserve of Kourtiagou; Decree no. 98–305/PRES/PM/MEE/MEF/MTT of 15 April 1998 which defines the regulations for the concessions, fauna management and the activities of concessionaries and guides, and (iii) Niger’s Tamou total reserve (778 km²) and the Dosso reserve (3 065 km²), classified by Decrees no. 76–141/PCMS/MDR of 12 August 1976 and no. 62–189/PRN/MER of 8 August 1962, respectively. This group of cross-border buffer zones constitute controlled land use zones. The main role players currently intervening in these zones could implement the development and specific management plans mainly focusing on the development of all the resources.

The transition area comprises the most anthropogenic spaces (agriculture, stock farming) that extend from the outer boundary of the buffer zone over a radius of several dozen kilometres in the three countries. It is noteworthy that the village zones of hunting interest at the periphery of the sport hunting concessions are an integral part of this transition area. The area encompasses village land where agro-sylvo-pastoral activities take place (village zones of hunting interest directly managed by the populations,

land management, etc.). However, with the fast advancement of cotton cultivation, the need for agricultural space is pushing the populations towards the transition zones. The transition zone should be the first to benefit from the economic and social development actions as well as ecosystem and resource rehabilitation actions that are to be initiated within the context of the transboundary biosphere reserve.

Much like in the entire Sahelo-Sudanese zone, the sustainable use of natural resources is a conflicting phenomenon within the populations (farmers and cattle breeders, migrants and sedentary groups), between the populations on a global level and local authorities (managers, line-functionaries and politicians) as well as global authorities (international conventions), and it is also complementary between these same role players. Therefore, the TBR management approach, particularly with regard to the ECOPASS programme interventions in the periphery, aims to stabilise the peripheral production systems (agricultural or pastoral) in space and time, while respecting the integrity of each zone's boundaries and functions.

5. Taking into account the interactions of the opposing parties

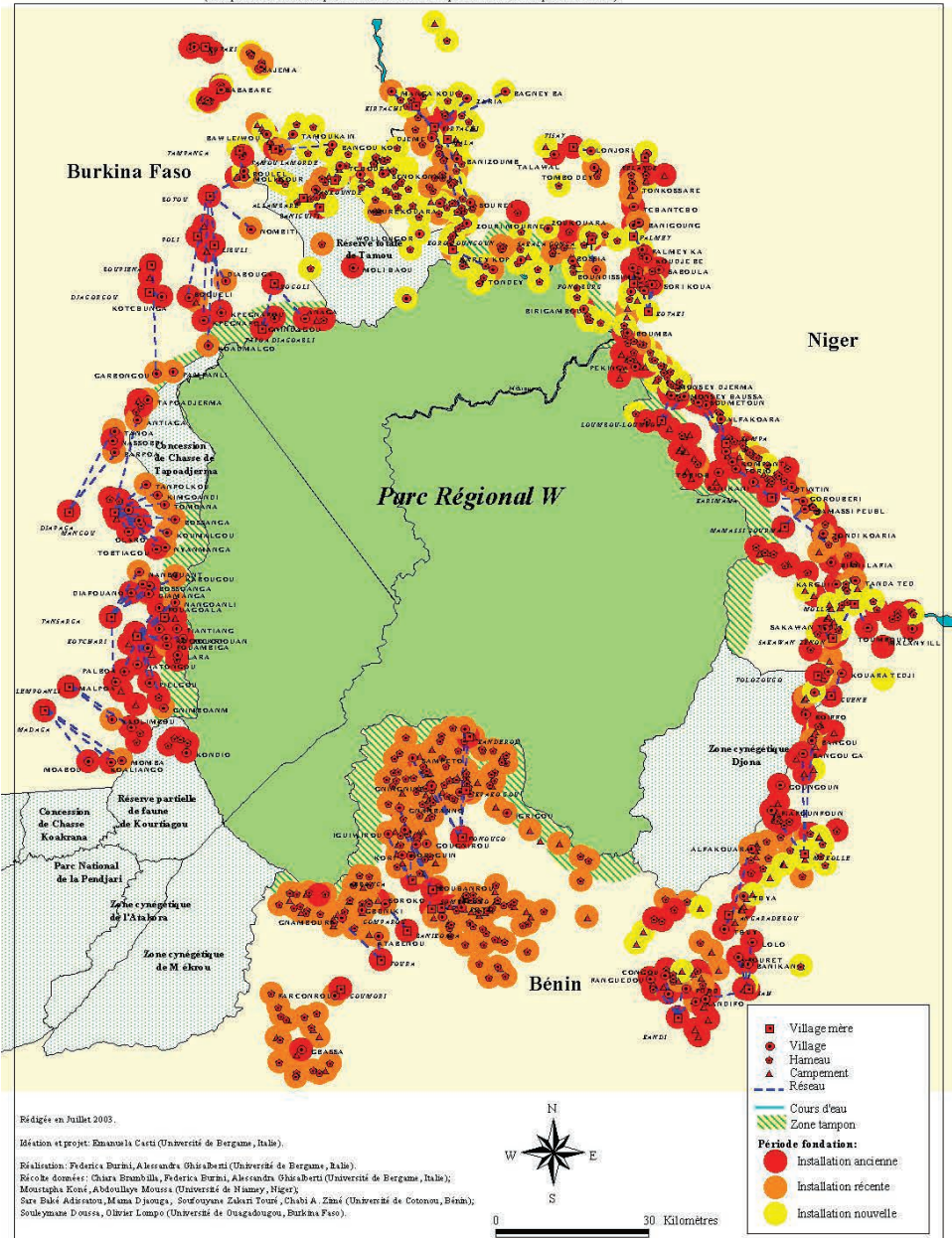
The resident population, essentially consisting of the Gurma (majority ethnicity), the Fula, the Hausa and the Zarma people, are agricultural people. The main crops include grains (millet and sorghum), and recently, cash crops (peanuts and cotton). Vegetable growing for the market concerns crops such as potatoes and various other vegetables. The animal species that are bred are among others: cattle, sheep, goats, donkeys, etc. While the craft industry and commerce are not highly developed, the proximity to the borders encourages smuggling, which especially concerns various commercial articles such as bicycle tyres, batteries, and some alcoholic beverages.

Various forms of interaction exist between the resident populations and the forest (Poda 2004) (Map 2):

1. Forests and watercourses are considered to be forms of divinity in the surrounding villages and are used as places of sacrifice: a large number of rites and customs (fetishes and various ceremonies) are consecrated there. There are still ancient village ruins from the period predating the area's classification, to which the populations still hold an attachment.
2. The forest is an extra source of food, and exercising one's right of use (collecting fruit, mushrooms, leaves for sauces, medicinal plants, and fishing) provides many essential elements for the populations' day-to-day life. The local farmers benefit from the zone's micro-climate which positively affects rainwater cultivation, and the stock farmers benefit from the pastures in the transition zone.
3. One of the W region's distinctive botanical features is the presence of large baobab populations (*Adansonia digitata*). These are generally situated on the higher parts of the plateau in wooded savannah areas and are linked to the ruins of fortified villages. Due to their significant utilisation in human economy (fruit, leaves and fibres), these

*L'évolution historique des villages riverains au Parc Régional W:
 stabilité et dynamisme*

(Carte provisoire* de la 3ème phase de la recherche sur les aspects socio-économiques pour le ZONA-GE)



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* On spécifie que les données sont préliminaires et seront vérifiées pendant les prochaines phases de la recherche.

Map 2

tree concentrations (which are frequently monospecific) can be considered to be the result of ancient anthropogenic activity, the ancient inhabitants of these zones having contributed to the germination and development of this useful species.

4. The local communities' involvement in the management of the proposed biosphere reserve will directly and indirectly provide them with income and considerable advantages of which some are listed below:
 - the development of village areas of hunting interest through the introduction of a leasing system between the concessionary and the populations in these zones;
 - the resident populations receive game meat (free of charge) stemming from tourist hunting parties. This meat is sold in aid of each village's wildlife management committee fund;
 - a percentage of the annual concession management tax, according to each country, is paid back to the populations.

These different sources of income stemming from the management of the proposed biosphere reserve make it possible for village wildlife management committees to generate significant amounts of money during each hunting season. These funds are generally invested in social activities benefitting the entire village (repairing the pump of the village's well drill, repairing the clinic's or maternity hospital's roofing, etc.).

5. Tourism (beautiful landscapes, biodiversity of the natural resources) is a means of developing the cultural potential of the zone (organising cultural evenings, visiting meaningful sites and monuments, etc.). The zone is in fact home to a traditional dance whose importance is recognised nationally. Another characteristic of the zone is the practice of divination based on geomancy (the interpretation of markings in the sand). This practice is used to predict the fate of an individual or event. In this way, significant contributions in kind or cash are generated by tourism for the benefit of the local populations (support for health schools and training programmes).
6. The region's administrative, political and customary authorities are highly attached to the classification act. Young generations who did not experience the classification of the forest learn about it through word of mouth; the elders show them the boundaries and boundary markers of the forest and also teach them their rights and responsibilities related to the classified zone. This attitude has made it possible to develop a sense of collective responsibility among the populations for the protection of the forest.

All the role players expressed a wish for the W Transboundary Biosphere Reserve to become reality and for the protective attitude towards natural resources to be maintained in order to support development during an era where an aggressive climate and human pressures on the environment are intensifying. This shows that there is more and more desire for local cooperation for the effective management of resources across the zonation. It constitutes an ideal framework for the implementation of the zonation which unites national policies for traditional and modern wildlife area management. However, this opportunity will not last if the development activities in the periphery

are not sustainable and do not take into account the different elements of the resident population.

6. The need for an integrating and sustainable view of the resources

Beyond the natural degradation conditions, anthropogenic pressures constitute major stresses to which zonation should provide answers. While permanent human occupation is not deplored in the central zone of the TBR, the situation is different in the buffer zone and the transition area, especially with regard to agricultural pressure. The most recent observations indicate a succession of new freshly cleared fields or fields in the process of being cleared all around the zone. Moreover, the peripheral zone is characterised by (Map 2) (i) a high population density of close to 500 000 inhabitants, with a very high growth rate, (ii) land saturation with an active agricultural front marked by cash crops, particularly cotton, (iii) a strong pressure exerted by grazing and transhumance, (iv) the populations' marked dependence on the protected areas' natural resources, estimated at 80% of their needs.

Despite the consensual zonation, each component of the W Park is also viewed from a national perspective, and the management of this protected area includes protection through monitoring, planning, development and recognition of the residents' rights in accordance with the national regulatory texts. The attachment to a former view of the national parks (the paramilitary character of the water and forestry officers on the front line) goes against the participative and regional development approach. Persisting feelings of resentment among the populations due to the colonial era's methods of intervention are sometimes maintained or even amplified by certain electoral promises of declassification or planning.

Cross-border management supplementing the national management on which it is based requires measures which are concerted, accepted and coordinated by the involved parties at all levels: monitoring and surveillance, planning, collection and distribution of information, and education and raising awareness among the populations. The cross-border nature of the W Transboundary Biosphere Reserve of Benin, Burkina Faso and Niger, provides the basis for regional exchanges relating to the conservation and sustainable use of natural resources. The pioneering nature of this cross-border characteristic in Africa paves the way for exchanges at the regional and global level. Here is where the concept of a transboundary biosphere reserve finds its meaning.

Despite the efforts made in the entire W Park, the three countries require a harmonised institutional and legal framework, such as the framework of a transboundary biosphere reserve which takes into account the integrated and participative management of shared transborder resources. This could be facilitated by the countries' joint adherence to shared integration organisations of a political, economic and social nature, such as the Economic Community of West African States (ECOWAS) and the West African Economic and Monetary Union ("l'Union Economique et Monétaire Ouest Africaine" UEMOA). The treaty of the UEMOA's 1994 creation in particular has made

environmental improvement one of the priorities in the domain of joint action. The treaty mentions the “cross-border character of the majority of environmental problems and the limited means of the States, taken individually, for facing these problems” and considers that a “regional approach to the management of natural resources and the environment will make it possible to develop the intervention capacities of the Member States, if the common objectives and the strategies for attaining them are defined together, in a concerted framework”.

It is also necessary for the international organisations such as the IUCN and UNESCO, who have a strong presence in the zone, to see eye to eye, which is not always the case with regard to conservation strategies (the Seville Strategy for biosphere reserves, UNESCO 1996, the recommendations of the IUCN’s Fifth World Parks Congress in Durban, South Africa, 2003). Regarding the adherence to international statutes and conventions, particularly the concept of biosphere reserves, the Ramsar Convention on Wetlands, the World Heritage Convention, the Convention on International Trade in Endangered Species CITES (Washington 1973), the 1979 Bonn Convention on the Conservation of Migratory Species of Wild Animals, bilateral projects each display their sense of identity, which goes against an integrated conservation and development approach.

The wish to promote the W-Arly-Pendjari (WAP) complex at tripartite encounters between Benin, Burkina Faso and Niger at the ministerial and expert level has been reinforced through the implementation of the ECOPASS project. It is necessary to encourage this dynamic within the context of national and international conservation strategies based on development and the joint management of resources. The W TBR together with zonation provide the ideal context for the utilization and conservation of natural resources in the WAP complex as a prelude to an integration of all the development tools of the entire WAP space (Benin, Burkina Faso and Niger).

7. Conclusion

The joint management of the W Transboundary Biosphere Reserve within the framework of local land development programmes and the decentralisation underway in Benin, Burkina Faso and Niger, takes into account the zonation and the cross-border character of the W Biosphere Reserve. This joint management, if successful, would serve as a model for protecting natural biological resources and threatened ecosystems. From this point of view, the transboundary biosphere reserve increases the chances for the success of the shared and integrated regional development programme between three countries.

Within the context of implementing the various functions of a transboundary biosphere reserve, UNESCO’s MAB programme is not the only one supporting cross-border management. Since 1998, the IUCN has accompanied Benin, Burkina Faso and Niger in a sub-regional conservation approach.

The joint approach of all the role players (development, research, financial partners) can reconcile the conservation of biodiversity and natural resources with their sustainable use for the benefit of the WAP’s global development. This approach would allow for

cross-border planning taking into account all the areas (water, land, fauna, flora, settlements, landscape) and all role payers, particularly the states' national interests, the concessionaries who are more oriented towards profitability, the resident populations who act as the first champions of conservation and who, in return, expect substantial spin-offs, and the international conventions which express the globalisation of conservation.

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A Sustainable Development Model for the Wine Lands of the Western Cape: A Case Study of the Cape Winelands Biosphere Reserve

Un modèle de développement durable pour la région des vignobles du Cap occidental: Etude de cas de la réserve de biosphère de la région des vignobles du Cap

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“There is nothing more difficult ...than to take the lead in the introduction of a new order of things.”—(Niccolo Machiavelli, 16th century)

Abstract

The Cape Winelands Biosphere Reserve in the Western Cape Province of South Africa has been designated by UNESCO in 2007 in terms of its Man and the Biosphere Programme. This scenically beautiful area slopes over the Cape Fold Mountains and includes towns, smaller settlements, rural communities, wine farms, commercial forests and protected areas with Fynbos vegetation. The biosphere reserve is clearly delimited into core, buffer and transition areas.

The Cape Winelands Biosphere Reserve is managed by a private company in collaboration with relevant stakeholders. It aims to equally address all three functions of a biosphere reserve with a focus on social upliftment and sustainable development. The biosphere reserve has drafted a spatial framework plan, based on bioregional planning principles, that provides detailed spatial guidance for future land-use management.

This paper discusses the establishment of the Cape Winelands Biosphere Reserve (CWBR) management entity, as well as the challenges and positive outcomes linked to the biosphere reserve. Through the application of social research methods, the effectiveness of the CWBR has been addressed in such a way that it could be compared to other biosphere reserves in the country. A case is made for use of the biosphere reserve concept, not only as a support mechanism to the South African protected areas expansion strategy, but also as a sustainable social-ecological land management tool.

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Résumé

La réserve de biosphère de la région des vignobles du Cap dans la province du Cap occidental en Afrique du Sud a été classée par l'UNESCO en 2007 aux termes de son programme Homme et Biosphère. Cette région aux panoramas exceptionnels surplombe les Montagnes du Cap Fold et héberge des villes, petits villages, communautés rurales, vignobles, forêts commerciales et zones protégées de végétation de Fynbos. La réserve de biosphère est clairement délimitée en zones centrales, tampons et de transition.

La réserve de biosphère de la région des vignobles du Cap est gérée par une société privée en collaboration avec les intervenants correspondants. Elle vise à aborder de manière équitable l'ensemble des trois fonctions d'une réserve de biosphère en portant une attention particulière sur l'élévation sociale et le développement durable. La réserve de biosphère a esquissé un plan-cadre spatial, basé sur les principes de planification biorégionale et définissant les principes directeurs de l'aménagement pour la gestion future de l'exploitation des terres.

Ce document porte sur l'établissement de l'entité de gestion de la réserve de biosphère de la région des vignobles du Cap (CWBR) ainsi que sur les enjeux et les résultats positifs liés à la réserve de biosphère. Par l'application de méthodes de recherche sociale, l'efficacité de la CWBR a été abordée de manière à pouvoir faire une comparaison avec d'autres réserves de biosphère dans le pays. L'argument est avancé pour l'utilisation du concept de réserve de biosphère, non seulement en tant que mécanisme de soutien à la stratégie d'expansion des zones protégées en Afrique du Sud mais également en tant qu'outil de gestion socio-écologique des terres.

Mots-cles: Réserve de biosphère; efficacité; entité de gestion; paysage; planification biorégionale; recherche sociale

1. Introduction

A mere 40 km inland from Cape Town lies one of the most beautiful areas in the world—the Cape Winelands. In 2007, a stretch of more than 300 000 hectares was designated by UNESCO as the Cape Winelands Biosphere Reserve (CWBR) and now forms part of the World Network of Biosphere Reserves.

The CWBR is located within the Cape Floristic Region that is regarded as a hot-spot for biodiversity conservation worldwide. The biosphere reserve is delimited into core areas of 99 459 ha, buffer zones of 133 844 ha and transition areas of 88 727 ha.

The nomination document clearly noted that the CWBR will be promoted as a site of excellence to support environmental sustainability and human well-being. It is therefore stated the CWBR would support the development of the Cape Winelands as “*an area of excellence and good practice for people, culture and nature*”. The main business of the management entity as described in the Memorandum of Association is “*to carry*

on the promotion, advancement and fulfilment of the three basic functions of a biosphere reserve". These functions are biodiversity conservation, sustainable development and logistic support.

The biosphere reserve is managed by a private company without share capital, incorporated under section 21 of the South African Companies Act in close collaboration with government departments, local authorities, landowners and communities. It has an approved spatial framework plan, is in the process of developing an integrated management framework and envisages implementing a sustainable development management model for the region.

The value of using the biosphere reserve concept lies in its ability to inclusively stretch beyond biodiversity by giving equal priority to socio-economic issues. This intrinsic value of the biosphere reserve concept is being realized through the CWBR. Although still in its early stages, the CWBR as a concept has the potential to become a well-managed, multidisciplinary planning tool that will guide future land management decisions in support of sustainable development.

2. Description of the Cape Winelands Biosphere Reserve Domain

The CWBR covers an area of 322 030 hectares in the Western Cape Province, bordering the City of Cape Town in the south westernmost corner of South Africa (Figure 1).

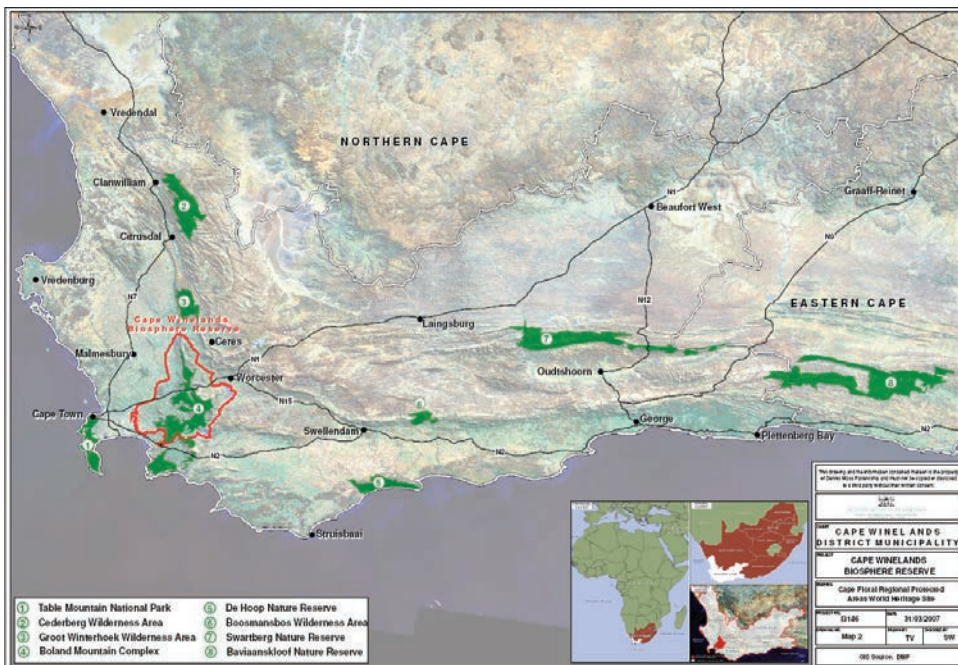


Figure 1: Location of the Cape Winelands Biosphere Reserve in South Africa
(Acknowledgement: Dennis Moss Partnership, Stellenbosch)

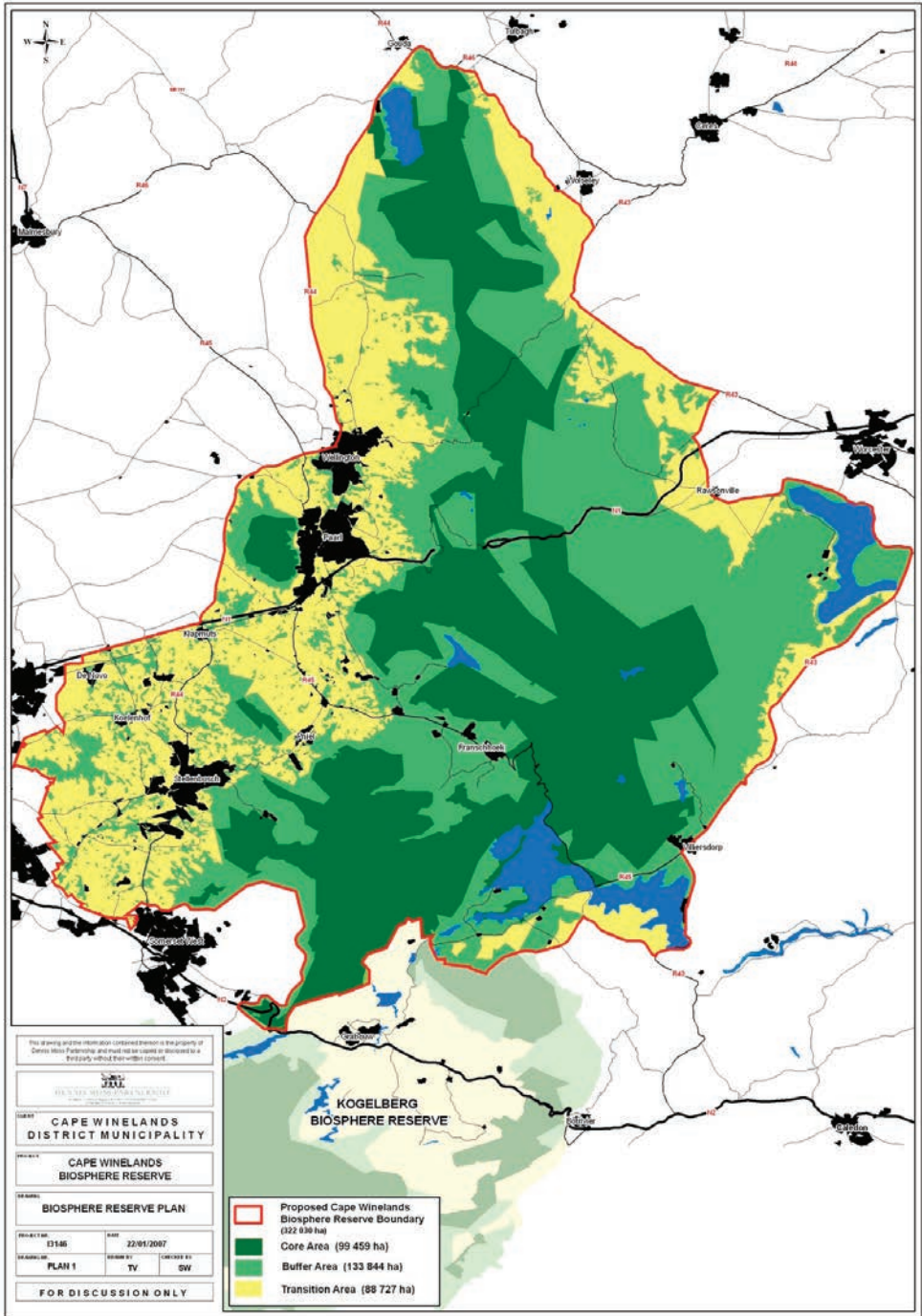


Figure 3: Zonation of the Cape Winelands Biosphere Reserve
 (Acknowledgement: Dennis Moss Partnership, Stellenbosch)

This region of immense beauty slopes across elevations from 20 m to 1860 m above sea level. It comprises wonderful geographical, biological and cultural diversity: the high Cape Fold Mountains, deep river valleys, rolling hills, commercial forests, world-renowned wineries, small agricultural settlements and beautiful historical towns (Figure 2). The CWBR shares a border to the south with the Kogelberg Biosphere Reserve and is in close proximity to the Cape West Coast Biosphere Reserve to the west.



Figure 2: Scenic beauty of the Cape Winelands Biosphere Reserve

(Photograph: Dennis Moss Partnership, Stellenbosch)

The biosphere reserve is delimited into core areas of 99 459 ha (31% of total area), buffer zones of 133 844 ha (42%) and transition areas of 88 727 ha (27%) (Figure 3). Core areas comprise statutory conserved provincial nature reserves, local authority nature reserves and one private nature reserve. Of the core areas, 93% is managed by one institution, namely the Western Cape Nature Conservation Board (CapeNature). Most of the core is situated along the slopes of high mountain ranges. Sections of the core area also form part of the extensive Cape Floral Region Protected Areas World Heritage Site. This was a serial nomination and the site was inscribed on the World Heritage List in 2004. It is made up of eight protected areas covering 553 000 hectares. One of the protected areas is named the Boland Mountain Complex. It includes, *inter alia*, the Hottentots Holland, Jonkershoek and Limietberg Nature Reserves, all of which form part of the CWBR core areas. Buffer zones include mostly natural areas that are registered as private nature reserves or are included in private conservancies. Some private mountain catchment areas (declared under the Mountain Catchment Areas Act of 1970), managed by CapeNature, are included as part of the buffer. Transition areas consist mainly of urbanized, cultivated and otherwise transformed lands.

The CWBR lies within the Cape Floristic Region (CFR) that is regarded as a hot-spot for biodiversity conservation worldwide (Myers *et al.* 2000). Of the species within the

CFR, 68% are endemic to the region (Cowling & Holmes 1992). The CFR includes all the vegetation types within the area known as the Fynbos Biome, commonly referred to as Fynbos (Rebello *et al.* 2006). The CWBR area comprises a number of different vegetation types, including Sandstone Fynbos, Shale Fynbos, Alluvium Fynbos, Shale Renosterveld, Granite Fynbos and Granite Renosterveld (Mucina & Rutherford 2006).

The CWBR has many outstanding features. It contributes greatly to conserving a large section of the globally important Fynbos and its associated biotic and abiotic elements. Core areas consisting of pristine natural landscapes form a continuous biodiversity corridor running from north to south through the biosphere reserve and linking up with mountainous areas of the Kogelberg Biosphere Reserve. In this way the functioning of valuable ecosystem processes is ensured as well as the preservation of habitat for large mammals such as the endangered Cape Leopard (*Panthera pardus*). An impressive list of plant species can be found in the CWBR, including representatives of the three main Fynbos components: the ericoid, restioid and proteoid components. Safe habitat is provided for a number of threatened species, such as the blushing bride (*Serruria florida*), *Diastella buekii*, *Moraea worcesterensis*, *Haemanthus pumilio* and *Gladiolus citrinus* (to name but a few). The area also boasts a large variety of birds. Some of the most conspicuous include the Cape eagle owl (*Bubo capensis*), African fish eagle (*Haliaeetus vocifer*), Verreux's (black) eagle (*Aquila verreauxii*), malachite sunbird (*Nectarinia famosa*), blue crane (*Anthropoides paradisea*), Cape sugarbird (*Promerops cafer*) and jackal buzzard (*Buteo rufofuscus*).

A significant number of reptiles and amphibians occur in the CWBR, including the endangered geometric tortoise (*Psammobates geometricus*), listed as one of the world's top 25 endangered turtles (Turtle Conservation Coalition 2011). Quite a few endangered butterfly and various endemic fish species also occur within the CWBR. Examples of fish include the critically endangered Witvis (*Barbus andrewii*) from the Berg River and the Berg River Redfin (*Pseudobarbus burgii*), restricted to tributaries of the Berg River (Skelton 1993).

Ecological corridors have been identified, mainly along major river courses that link core and buffer areas and allow genetic movement within ecosystems.

The region has been inhabited since approximately 1 million years ago with the ancestors of the San people, the first known indigenous human population. In 1652 Europeans colonized the surrounds of the Cape of Good Hope as a stop-over for sailing vessels. The first village to be established outside of Cape Town was Stellenbosch when Governor Simon van der Stel allocated a number of farms on the banks of a river that he crossed and aptly named Eerste River (translation: First River). By the end of the nineteenth century the major towns and villages of the CWBR were established, including Stellenbosch, Paarl, Wellington and Franschhoek. The rich history of the last 330 years is palpable when one walks the streets of these towns with beautifully preserved historical buildings that loom from every corner. Stellenbosch, Paarl and Wellington are the most densely populated towns in the CWBR. The total permanent population of the biosphere reserve area is approximately 320 000. Only about 35% of the population is employed and a staggering 54% has no income (Cape Winelands District Municipality 2007). These figures show clearly that a very large percentage of the CWBR population

live in abject poverty, which is a core challenge to be faced by relevant administrations, including the biosphere reserve management entity.

As the name implies, the wine lands region is also probably the most famous for its epic wine routes. The Stellenbosch Wine Route is the oldest wine route in South Africa and provides for a wonderful wine experience. It is divided into five sub-routes and includes more than 200 wine and grape producers. The agricultural sector is therefore one of the main providers of employment.

The University of Stellenbosch is the second oldest university in the country and is home to some 22 000 students. With three biosphere reserves on its doorstep, the university is becoming more and more involved in research projects related to the biosphere reserve concept and using biosphere reserves as study sites.

The region is very well known worldwide for its vernacular architectural styles, including Early Cape and Cape Dutch. The Stellenbosch Village Museum boasts the oldest restored townhouse in the country—the Schreuderhuis. Many excellent examples of Cape Dutch homesteads are dotted around the CWBR, as well as beautifully restored buildings from other eras such as Georgian, Edwardian and Victorian.

Large reservoirs, receiving crystal clear water from various mountain ranges, provide services to populated areas both inside and outside of the CWBR. Water runoff in Fynbos catchments is amongst the highest in South Africa. Provision of clean water is one of the major ecosystem services of the biosphere reserve. At the same time changes in land-use patterns could have a potential seriously detrimental impact on this service.

The nomination document of the CWBR was drafted in such a way as to position the biosphere reserve as an entity to facilitate sustainable development which would serve as a mechanism against poverty and inequality. It was stated that the management entity of the biosphere reserve “*will function under the auspices of the District Municipality and will be accountable to the latter*” (Cape Winelands District Municipality 2007). It was foreseen for the management entity to eventually be a registered non-profit company.

The nomination document clearly noted that the CWBR will be promoted as a site of excellence to support environmental sustainability and human well-being. It is therefore stated the CWBR would support the development of the Cape Winelands as “*an area of excellence and good practice for people, culture and nature*” (Cape Winelands District Municipality 2007). The main business of the management entity as described in the Memorandum of Association is “*to carry on the promotion, advancement and fulfilment of the three basic functions of a biosphere reserve*”. These specific functions are conservation of biological diversity; sustainable development; and logistic support that includes research, education and training.

3. Inception of the Cape Winelands Biosphere Reserve

During 1990 the then Chief Directorate of Nature and Environmental Conservation of the Western Cape Province (presently known as CapeNature) drafted a document on a potential holistic conservation strategy for the entire Fynbos Biome (Burgers *et al.* 1990). This document promoted the establishment of a single Fynbos Biome biosphere

reserve, which could have been perceived as a 'cluster biosphere reserve' (Stanvliet *et al.* 2004) and initiated wide deliberations with regards to the use of the MAB Programme and the implementation of biosphere reserves. The core areas of what would many years later become the Cape Winelands Biosphere Reserve were already depicted on the map accompanying the document (Stanvliet 2009).

In May 2000 the first Southern African biosphere reserve learning seminar was held at the Hans Hoheizen Research Station at the Southern African Wildlife College in the Kruger National Park. In a report on this seminar, delivered during the Seville +5 international meeting of experts in Pamplona, Spain later that year, the so-called Boland Biosphere Reserve (similar area to the CWBR) was noted (Naude 2001). The idea for a biosphere reserve had its origins in 1998 with the Stellenbosch Municipality and University of Stellenbosch, and was grounded in the Stellenbosch structure plan (Moss 2009). The name originated with the merging of the then Breede River District and Winelands District into the Boland District in the run-up to the 2000 national elections (Johnson 2010). Since 2002 the Boland Biosphere Reserve idea was promoted by municipalities and documentation was generated regarding a proposed Boland Biosphere Reserve. In June 2005, the then Executive Mayor of the Cape Winelands District Municipality and other representatives visited UNESCO in Paris, France, to discuss key aspects of the biosphere reserve proposal. Later in 2005 during a consultative process the name Cape Winelands Biosphere Reserve was decided upon. At a District Municipality council meeting in August 2005, a resolution was taken to "*seek support of all stakeholders for the establishment of a biosphere reserve.*"

The outer boundaries of the CWBR correspond with bioregions in accordance with the bioregional planning guidelines of the Western Cape Province (Department of Planning, Local Government and Housing 2000). At local administration level, the CWBR comprises the entire area of Stellenbosch Municipality, as well as sections of Drakenstein, Breede Valley, Witzenberg and Theewaterskloof Municipalities. The main champion is the Cape Winelands District Municipality. The latter envisaged caring for the biosphere reserve not to be a future liability or so-called "*optional extra*" but to eventually form an integral part of municipal functions. This notion led to the generally accepted principle that responsibilities of municipalities versus that of the biosphere reserve management entity will have to be very clearly defined.

A team of consultants was appointed and funded by the District Municipality to compile the formal nomination to UNESCO. The process included an extensive public participation process, focusing mainly on private landowners with the view to obtain increasing support for the biosphere reserve. The very detailed and lengthy nomination was very well received by UNESCO and eventually led to the CWBR's designation in September 2007.

4. Implementation of the Cape Winelands Biosphere Reserve

4.1 Interim arrangements

After designation, more than a year lapsed while administrations were deliberating the institutional future of the biosphere reserve. In November 2008 the Cape Winelands

District Municipality established an interim steering committee to provide guidance to the CWBR until such time as the formal management entity would be in existence. The interim committee facilitated two important processes, namely (i) drafting of a spatial framework plan for the CWBR, and (ii) compiling documentation towards the establishment of a non-profit company as the management entity.

Specific goals of the CWBR were identified (Cape Winelands District Municipality 2010 — see Box 1).

Box 1: Goals of the Cape Winelands Biosphere Reserve

International level

1. Provide practical ways to resolve land-use conflict and to protect biological diversity
2. Provide opportunities and share ideas for education, recreation and tourism to address conservation and sustainability issues
3. Co-operate on thematic projects or on ecosystem types
4. Create a connection among people and cultures worldwide on how to live in harmony with the environment and each other

Local level

1. Help create and maintain a healthy environment for people and their families
2. Maintain productive and healthy landscapes
3. Reduce conflict among people
4. Encourage diverse local economies to revitalize rural areas
5. Increase the involvement of communities in land-use decisions and thus the connection to the land
6. Support and facilitate interconnected scientific studies and monitoring
7. Celebrate cultural diversity and provide opportunities to maintain existing traditions and lifestyles

As a first priority a biosphere reserve Framework Plan, based on bioregional planning principles, was drafted with various opportunities in the course of the process for stakeholders, including landowners, to provide inputs. Bioregional planning makes use of a system of Spatial Planning Categories that were originally based on the UNESCO biosphere reserve zonation system. The final CWBR Framework Plan was adopted in 2010 by the Cape Winelands District Municipality as biosphere reserve custodian and provides detailed spatial guidance for future land-use management.

Through a consultative process, the management entity to champion the CWBR was selected by the interim committee to be a private non-profit company, registered under Section 21 of the Companies Act. An interesting point of discussion with inception of the biosphere reserve was the positioning of the management entity as a “*development agency*” (Cape Winelands District Municipality 2007). It was argued that this notion will put the biosphere reserve in direct opposition to the municipalities, which have a defined development oriented agenda according to the Municipal Systems Act (Act 32 of 2000).

However, Brandon (1997) noted that conservation agencies would likely become rural development organizations in partnership with other stakeholders. An example is the Uckermark Lakes Nature Park in Germany that puts itself out as a servicing agency

for local interests (Stoll-Kleemann & O’Riordan 2002). Such comprehensive management agendas could be a characteristic of modern biosphere reserves and, if appropriate, be translated into objectives of the biosphere reserve management entity.

4.2 Management entity

The Cape Winelands Biosphere Reserve Company was formally registered as a non-profit company during 2010. The interim committee was transformed into a management committee. The structure of the management committee incorporates a Board of Directors, a technical committee providing technical advice to the Board and a coordination unit. This resulted in quite a similar management structure to the other two biosphere reserves in the Western Cape Province — Kogelberg and Cape West Coast. The management committee adopted the vision of the CWBR as stated in the nomination document: “*An area of excellence and good practice for people, culture and nature*”. The committee meets on a monthly basis. Each Director is allocated a specific portfolio as indicated on the membership application form (Box 2).

Box 2: Functions of the CWBR established as Portfolios

1. Administration
2. Economic Development and Planning
3. Tourism and Heritage
4. Biodiversity and Research
5. Marketing, Public Relations and Communications
6. Community Affairs, Labour and Education
7. Agriculture and Mining
8. Business and Corporate Engagement
9. Fund raising
10. Finance

The functions of the management committee are listed in Table 1. Drafting of a CWBR Strategic Management Framework and Business Plan has been identified as a high priority for the CWBR Company to address in the very near future. Since late 2010 the CWBR is actively implementing an awareness campaign that includes information leaflets and banners. A new biosphere reserve logo was formally approved at a meeting on 7 December 2010 (Figure 4).

Table 1: Functions of the Cape Winelands Biosphere Reserve Management Committee

1. Facilitation of employment creation and economic growth.
2. Support for implementation of collective local, provincial and national government projects where the biosphere reserve is concerned.
3. Globalisation and promotion of international competitiveness.
4. Creation of enabling environments for private sector growth and public-private partnerships.
5. Procurement and appropriate allocation of development funding.

6. Provision of support, expertise, guidance and funding to local business, especially SMME's (Small, Medium and Micro Enterprises).
7. Preparation of a detailed land-use pattern in the form of a comprehensive framework plan.
8. Implementation of a multi-stakeholder approach, with specific emphasis on the involvement of local communities in issues that influence them directly.
9. Resolution of conflict pertaining to the use of resources and development.
10. Integration of cultural and biological diversity in ecosystem management through the use of traditional knowledge and science.
11. Demonstration of sound implementation and management policies in conservation and in all economic sectors represented in the biosphere reserve.
12. Development of a culture of learning, training and education throughout the local communities.
13. Support for development strategies that build upon and promote the comparative and competitive advantages of the region; in particular the promotion of the role of responsible tourism in the Cape Winelands Biosphere Reserve.
14. Development and regulation of a biosphere branding and marketing strategy aimed at improving the comparative and competitive status of the biosphere reserve in the global arena.



Cape Winelands
BIOSPHERE RESERVE

Rationale

This logo uses many components to get its meaning across. Human figures within the leaves point to the need for humankind and nature to live in balance to survive. One cannot function without the other and both are important elements in a vast circle called life.

How important is the simple leaf to life on earth? Light is processed through the cells of a leaf to create energy. During this process of photosynthesis, oxygen is released into the atmosphere. Leaves, from the smallest plants hugging the earth to the mightiest trees that tower far above us, are a food source for just about all living creatures, from the insect to the elephant, not to mention human beings.

The single leaf is an ancient heraldic symbol said to signify happiness, healing and of peace and quiet. The Biosphere will inspire these values in those who choose to live in the reserve; happiness in a beautiful surrounding, healing of the environment and peace and quiet in an area where humans and nature function well together.

Leaves are also potent symbols of regeneration and resurrection as they cycle through the seasons. This brings forth positive associations of humans using wisdom to resurrect and regenerate an environment that has in previous generations taken a beating.

This symbol is a good representation of mankind "turning a new leaf" and beginning a new life in which nature isn't ravished and destroyed but rather cherished and valued.

Figure 4: New logo of the Cape Winelands Biosphere Reserve
(approved in December 2010)

The first annual general meeting of the CWBR Company took place on 26 May 2011 at which people were nominated and elected to serve as the first Directors of the Company. Company structures are to include the following:

- Subscribing members — individuals, paying a membership fee, that subscribe to the vision and mission of the CWBR and have voting rights at annual general meetings.
- Institutional membership — institutions and non-governmental organizations (e.g. Conservancies) positively indicating a synergy and compatibility with the objectives and goals of the CWBR.
- Business/Corporate membership — small, medium sized and national businesses wishing to support the aims of the CWBR and paying varying membership fees according to the size category to which it belongs.
- Partners — five crucial partners have been identified, namely a local university as an academic partner to assist in executing the biosphere reserve's research responsibilities; an auditing partner that will contribute bookkeeping and auditing services; a banking partner that will provide banking facilities to the CWBR; a legal partner that will look after the interests of the CWBR Company; and a local government partner, a role that is currently being fulfilled by the Cape Winelands District Municipality. Only technical support, no financial support, will be required from these partners, except the District Municipality.
- Co-opted secretariat, currently provided by the Cape Winelands District Municipality.

4.3 *Financial security*

During the previous political dispensation in the Cape Winelands District Municipality, the CWBR was generously supported with sufficient financial means to compile the nomination and relevant documentation, including awareness materials. Recently, however, the district municipality ceased supporting the biosphere reserve to the same financial extent although they still provide most needed secretarial services to the biosphere reserve. Despite the biosphere reserve's rather bleak financial situation at present, the CWBR is planning for a secure financial future with support from different categories of membership. The Western Cape Biosphere Reserves Act (Government Gazette Extraordinary 6936 of 13 December 2011) makes provision for financial assistance from the provincial Government for the management or extension of a biosphere reserve. The aim of the CWBR is, however, to move away from government supported funding systems towards financial support from the private market.

5. *Methods of the Cape Winelands Case Study*

In 2011 a case study was conducted on the Cape Winelands Biosphere Reserve, using a specific social research methodology (Stanvliet 2010) that included the following techniques:

- (i) Unobtrusive content analysis;

- (ii) Semi-structured and open-ended interview surveys with five stakeholders, based on a set of questions distilled through a literature review process to reflect the effectiveness of the biosphere reserve (Merton & Kendall 1946; Table 2);
- (iii) Questionnaire surveys with seven major stakeholders, representing private land-owners, tourism, research, district municipality, conservation management, spatial planning, and local municipality;
- (iv) Participant observations (Sandström 2008) and direct observations.

Table 2: List of components to be used in semi-structured interviews on the effectiveness of South African biosphere reserves

Component	Detailed questions and description
Three functions according to UNESCO's Seville Strategy	<ul style="list-style-type: none"> • To what extent does the biosphere reserve reflect the three functions of conservation, development and logistic support? (UNESCO 1996, 2002) • Please expand on collaborations and projects covering the three functions. • Does the biosphere reserve have specific programmes and/or projects for scientific research, biodiversity monitoring and environmental education? (Lü <i>et al.</i> 2003, Queensland Parks and Wildlife Service 2002, UNESCO 1996, 2002)
Zonation system of three elements according to UNESCO's Seville Strategy	<ul style="list-style-type: none"> • Does the biosphere reserve reflect the three zones of core, buffer and transition? (UNESCO 1996, 2002, 2008) • Were guidelines drafted in relation to management objectives and appropriate land uses for each zone?
Seven criteria according to the Statutory Framework of the World Network of Biosphere Reserves	<ul style="list-style-type: none"> • Which biogeographic regions or biomes is this biosphere reserve representing? (Pressey & Taffs 2001, UNESCO 1996, 2002) • What is the total size of the biosphere reserve? (Ervin 2003, Pressey & Taffs 2001, UNESCO 1996, 2002) • What is the extent of the three individual zones that make up the biosphere reserve?
Nomination history	<ul style="list-style-type: none"> • Please expand on historical aspects of the UNESCO nomination. Why was the biosphere reserve concept selected for this specific area? • Is the biosphere reserve being perceived as somewhat different to another type of protected area/landscape initiative? (Robertson Vernhes 2007, Stanvliet 2009) • If yes, please discuss. • Has the biosphere reserve taken part in a periodic review process? (UNESCO 1996, Price 2002) • If yes, please expand on benefits of this process.
Aspects of Implementation	
Institutional authority	<ul style="list-style-type: none"> • Does the biosphere reserve have a designated institutional authority? (Corbett 1995, UNESCO 1996, 2002) • If yes, what form of authority? • Please explain the representivity of the authority within the region.
Financial resources	<ul style="list-style-type: none"> • Does the biosphere reserve have secure long-term financial resources to operate efficiently? (Corbett 1995, Pasquini 2003, Stoll-Kleemann & Job 2008, UNESCO 2002)

Component	Detailed questions and description
Regional planning	<ul style="list-style-type: none"> • Has the biosphere reserve zonation been taken up in regional planning frameworks and legislation? (UNESCO 2008) • If yes, please explain. • Has any specific land-use guidelines or performance standards been drafted for each zone? (UNESCO 2008) • If yes, please provide details.
Management framework	<ul style="list-style-type: none"> • Does the biosphere reserve have an approved management plan or framework? (Ervin 2003, Pressey & Taffs 2001, Stoll-Kleemann & Job 2008, UNESCO 1996, 2002) • How many staff members are designated to the biosphere reserve, responsible for implementing the management plan? (Pasquini 2003) • Is there an independent office space from where the biosphere reserve is being coordinated? • Does the biosphere reserve have a clearly defined vision and objectives? (Hockings, Stolton & Dudley 2000) • Does the management framework address the complementarity and responsibilities of stakeholders relating to biosphere reserve objectives? (Hakizumwami 2000, UNESCO 2002)
Legislation and government support	<ul style="list-style-type: none"> • How are biosphere reserves being reflected in national legislation? (Hakizumwami 2000, Stoll-Kleemann & Job 2008) • What kind of support is being given to biosphere reserves from local, regional and national authorities? (Dudley <i>et al.</i> 1999, Stoll-Kleemann & Job 2008)
Partners/ Stakeholders	<ul style="list-style-type: none"> • Is the biosphere reserve actively pursuing partnerships with specific stakeholders such as public authorities, local communities, private land-owners and visitors? (Hakizumwami 2000, Queensland Parks and Wildlife Service 2002, UNESCO 1996, 2002) • According to you, which benefits are being derived for the general public as a result of the existence of the biosphere reserve?
Threats/Challenges	<ul style="list-style-type: none"> • Please expand on major threats to the biosphere reserve, such as extractive industries, poaching, pollution, political changes, changes in land-use, etc. (Dudley <i>et al.</i> 1999, Pasquini 2003, UNESCO 1996, 2002) • Are there adaptive management policies in place to address these challenges?

Data obtained through content analysis, interviews, questionnaire surveys and observations were used towards a complete portrayal of the historical past and present situation of the Cape Winelands Biosphere Reserve.

The questionnaire consisted of a box for personal information and question boxes 2 to 4. Responses to question box 2 were analyzed by determining the level of agreement amongst responses (Margoluis & Salafsky 1998). This question box provided interviewees the opportunity to put forward an opinion on five questions of a general biosphere reserve nature. The third box addressed problems and challenges faced by the CWBR. Interviewees were given ten elements to order in priority from highest to lowest. The responses were analyzed with matrix ranking, specifically preference ranking (Margoluis & Salafsky 1998). The fourth box addressed positive elements linked to the CWBR. Interviewees were again given ten elements to order in priority from highest to lowest. The responses were analyzed with preference ranking (Margoluis & Salafsky 1998).

6. Results

The first question referred to the issue that a series of instruments are being used in the South African context with which to practise landscape scale management, such as World Heritage Sites, biodiversity initiatives, transfrontier conservation areas, biosphere reserves and megareserves (Stanvliet 2009). All seven interviewees gave a “yes” response to the question whether the biosphere reserve concept is a useful tool for landscape management (Figure 5).

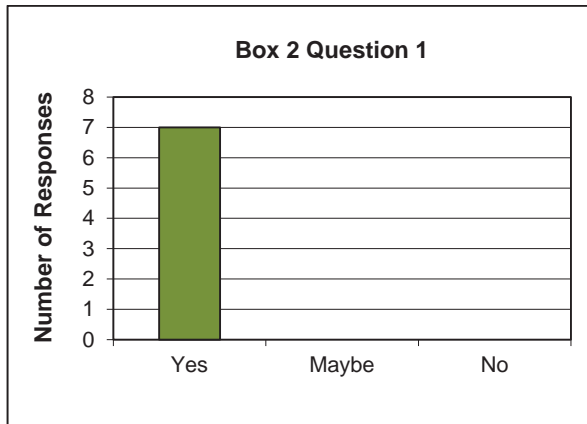


Figure 5: Frequency diagram depicting responses to the question “In your opinion, is the biosphere reserve concept a valuable tool with which to do landscape management in South Africa?”

The second question deals with the expectation of the public that the biosphere reserve designation would add value to the region. This is important in view of the high expectations of the public in this regard. Three interviewees reacted positively, three mentioned “somewhat” and one said “no” (Figure 6). The latter interviewee noted “unless the custodians of biodiversity are given teeth ... the biosphere reserve will not be effective”.

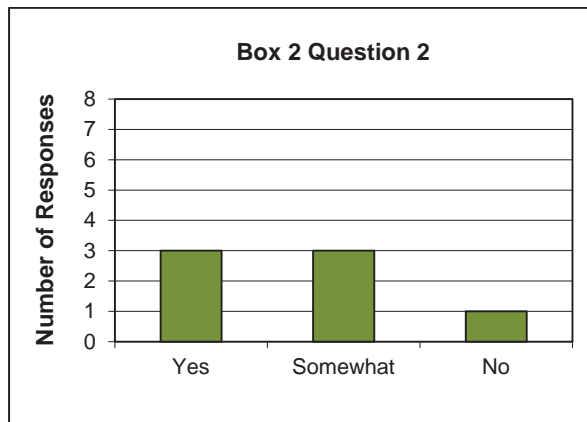


Figure 6: Frequency diagram depicting responses to the question “In your biosphere reserve, do you think the designation is adding value to the area?”

The third question elicited a reaction on institutional support for the CWBR. All seven interviewees responded “yes” to the question whether the organization they represent supports the idea of a biosphere reserve (Figure 7).

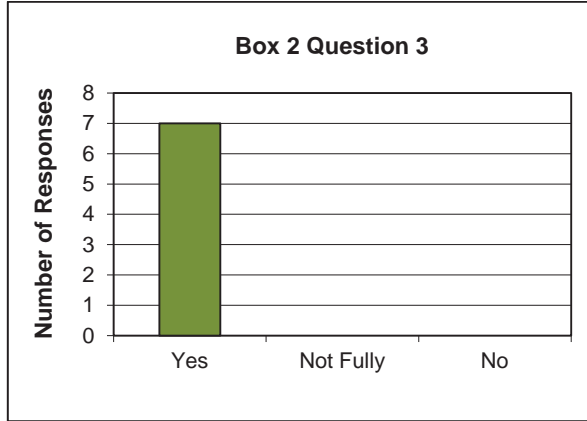


Figure 7: Frequency diagram depicting responses to the question “Is the organization that you represent in support of the biosphere reserve?”

The fourth question asked whether interviewees thought the biosphere reserve was managed effectively. It produced interesting opinions on the ideal of an effective biosphere reserve. Four interviewees responded positively and three with “somewhat” (Figure 8).

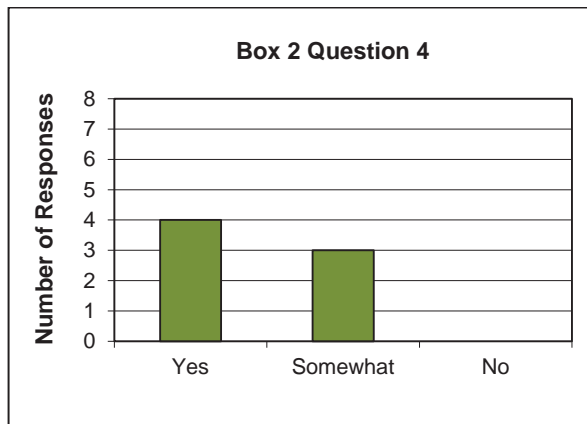


Figure 8: Frequency diagram depicting responses to the question “Are you of the opinion that the management entity of your biosphere reserve is doing a good job of managing the biosphere reserve effectively?”

The last question on whether the interviewees were considering biosphere reserves as special places for people and nature yielded a positive response by five interviewees whereas two responded “sometimes” (Figure 9). The outcome of this question proves that people in general do believe in the potential of the biosphere reserve concept, something that could be used to the advantage of the South African biosphere reserve

fraternity in future. However, one interviewee specifically noted that the biosphere reserve concept is much more effective if applied in a smaller homogenous area. In larger biosphere reserves, diverse populations are being divided by natural boundaries which also sometimes act as social boundaries and complicate biosphere reserve awareness and marketing projects.

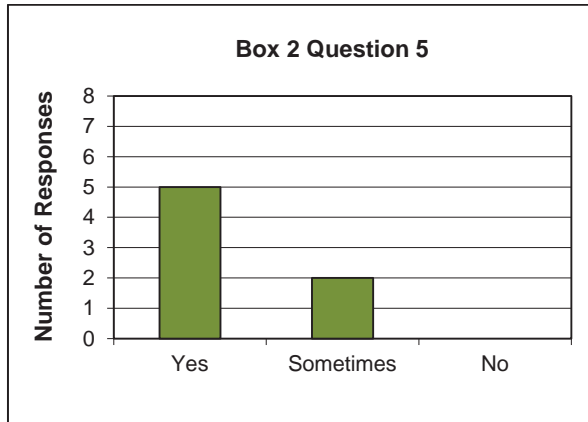


Figure 9: Frequency diagram depicting responses to the question “Do you truly agree with the statement ‘biosphere reserves are special places for people and nature’?”

The collective ranking ranking of problems and challenges (listed in Box 3) from highest to lowest came out as follows:

1. Insufficient long-term financial resources
2. Too little benefits perceived by local communities resulting in a lack of support
3. Too little awareness amongst role-players and local communities
4. Lack of support (buy-in) from local authorities
5. Lack of designated biosphere reserve personnel
6. Lack of long-term vision and objectives
7. Not enough insight into the value of implementing the biosphere reserve concept
8. Insufficient legal means (lack of ‘teeth’) to implement the biosphere reserve concept
9. Too much of a conservation (green) focus and not enough emphasis on other issues such as development
10. Biosphere reserve concept not strongly supported by national government

The high priority given to factors such as funding problems, lack of awareness and support, and the lack of benefits to local populations is probably due to the fact that the WCBR has only been in existence for such a short period of time.

A specific challenge noted by one interviewee, was for the biosphere reserve to coordinate activities between different institutions to allow for greater acceptance of the CWBR’s vision. The task of convincing people of the benefits of a biosphere reserve was also highlighted as a challenge. Urban sprawl and increased development in rural areas were noted as a particularly serious problem. A patchwork of residential developments in rural areas will erode the character of the region and could result in a perpetuation of

“*apartheid planning*” where the rich are grouped within security estates albeit with some financial benefits flowing to poor communities.

The collective ranking from highest to lowest of the positive elements linked to the CWBR came out as follows:

1. The biosphere reserve creates awareness about sustainable development
2. The biosphere reserve provides a means to attract international funding to the region
3. The biosphere reserve has resulted in people becoming more aware of their interconnectedness to the natural environment
4. & 5. The biosphere reserve creates an opportunity for communities to be involved in management decisions about the future of their area
4. & 5. The biosphere reserve concept is a tool with which to facilitate collaborative management to the benefit of the region
6. The biosphere reserve creates international visibility for the area
7. A biosphere reserve is much different (in a positive way) to a traditional protected area such as a national park or nature reserve
8. The biosphere reserve attracts more tourists/visitors
9. The biosphere reserve created more jobs in the area
10. The biosphere reserve resulted in increased property values

It is interesting to note that there is some agreement in the top rankings of both the challenges and positive elements. In clarification, a number of interviewees mentioned the difficulty to provide a clear record of positive elements because the CWBR has only been an active entity for about two years. Thus most listed positive aspects are being perceived as potential and will only be realised once the management entity is in full operation and sufficiently funded. Nonetheless most are of the opinion that the CWBR has the potential to become a truly efficient biosphere reserve, a tool with which to address pressing issues such as climate change, and an example to other South African biosphere reserves in future.

Different opinions were provided on the actual value of the biosphere reserve concept. In this specific region it is of special importance due to the fine line between responsibilities of the district municipality and the biosphere reserve management entity. Bioregional planning principles are in any case implemented within local authorities through spatial planning processes. These are further refined through the biosphere reserve framework plan. However a designated biosphere reserve does provide international recognition for areas of exceptional significance from a global perspective.

In more than one interview the importance of using relevant legislation to ensure implementation of the biosphere reserve was emphasized (Johnson 2010, Volschenk 2010, Le Keur 2011). These comments must be seen in light of the lack of enforcement mechanisms forthcoming from the MAB Programme itself (Schliep *et al.* 2008).-

In 2011, the CWBR has approved a Framework Plan (Anon. 2011) that puts forward a very detailed guide for future land-use management. The plan is mapped on a 1:5000 scale using 36 Spatial Planning Categories and is integrated within the five involved

local authorities. This Framework Plan used bioregional planning principles as a point of departure and provides an implementable land-use management tool to guide future sustainable development.

One of the interviewees raised an interesting perception that a biosphere reserve must be run on sound business principles, albeit with some flexibility (Holmes 2010). The CWBR is currently experimenting with a new concept of financing biosphere reserves that involves a move away from government funding towards funding by the private business world. The selling point is the opportunities for development and sustainability that are being provided by the biosphere reserve model (Holmes 2010).

The CWBR is being perceived in a generally positive light by all interviewees. Some forthright critique was also noted, specifically related to lack of involvement of historically disadvantaged communities in the management framework. Concern was expressed over the uncertain funding mechanisms of the biosphere reserve. A long-term solution could potentially be found in facilitating joint South African biosphere reserve funding applications to potential national and international donors. A so-called “technical virtual network facility” (Johnson 2010) could be useful in obtaining inputs from all six biosphere reserves in the country.

The semi-structured interviews provided additional opinions related to the effectiveness of the CWBR. Descriptive results are summarized in Table 3. A general rating of between 1 and 3 (where 1 means not meeting the criteria at all, 2 means a middle of the road performance, and 3 means a good performance) was allocated for each component based on the performance of the biosphere reserve as expressed by the interviewees. Out of a potential total of 33, the CWBR scored 24 (72.7%). This result would place the CWBR in a joint third position when ranked with the five other South African biosphere reserves, a low position which is understandable in view of the short time this biosphere reserve has been in existence.

Table 3: Results from semi-structured interviews on the effectiveness of the Cape Winelands Biosphere Reserve

Component	Descriptive results	Rating24/33
Three functions according to UNESCO's Seville Strategy (Lü <i>et al.</i> 2003, Queensland Parks and Wildlife Service 2002, UNESCO 1996, 2002)	The CWBR is not yet fully operational. Conservation function is on-going and executed by conservation officials. A biosphere reserve marketing campaign is active. Discussions with the University of Stellenbosch on strengthening the research function have been initiated. Development function is to relate to evaluation of development proposals specifically in buffer zones to reflect biosphere reserve principles.	2
Zonation system of three elements according to UNESCO's Seville Strategy (UNESCO 1996, 2002, 2008)	All three elements covered in the total size of 322 030 hectares. The biosphere reserve is delimited into core areas of 99 459 ha (31% of total area), buffer zones of 133 844 ha (42%) and transition areas of 88 727 ha (27%). Guidelines for land uses within the distinct zones are incorporated as part of the CWBR framework plan.	3

Component	Descriptive results	Rating^{24/33}
Seven criteria according to the Statutory Framework of the World Network of Biosphere Reserves (Ervin 2003, Pressey & Taffs 2001, UNESCO 1996, 2002)	The CWBR lies within the Cape Floristic Region that is regarded as a hot-spot for biodiversity conservation worldwide. The biosphere reserve slopes across elevations from 20 m to 1860 m above sea level. It is of sufficient size (322 030 ha) and is representative of a biogeographic zone that is not yet sufficiently covered in a biosphere reserve.	3
Nomination history (Price 2002, Robertson Vernhes 2007, Stanvliet 2009, UNESCO 1996)	Designation of the CWBR (previously known as the Boland BR) followed onto a process of a proposed Fynbos Biome cluster BR. The CWBR had its origins in 1998 with the Stellenbosch Municipality and University of Stellenbosch and was grounded in the Stellenbosch structure plan. In June 2005, the then Executive Mayor of the Cape Winelands District Municipality and other representatives visited UNESCO in Paris, France, to discuss key aspects of the biosphere reserve proposal. A team of consultants was appointed to compile the formal nomination to UNESCO. The process included an extensive public participation process, focusing mainly on private land-owners with the view to obtain increasing support for the biosphere reserve.	3
Aspects of Implementation		
Institutional authority (Corbett 1995, UNESCO 1996, 2002)	The designated institutional authority is a private company without share capital, incorporated under section 21 of the Companies Act. The institutional authority is earmarked to operate in close collaboration with government departments, local authorities, landowners and communities. Currently the biosphere reserve is being managed by an interim management committee in collaboration with the Board of Directors of the Company. However, some communities still feel excluded from the management process.	2
Financial resources (Corbett 1995, Pasquini 2003, Stoll-Kleemann & Job 2008, UNESCO 2002)	During the previous political dispensation the CWBR was generously supported with sufficient financial means to compile the nomination and relevant documentation, including awareness materials. Recently, however, the district municipality is not nearly supporting the biosphere reserve to the same financial extent although they still provide most needed secretarial services to the biosphere reserve. Despite their rather bleak financial situation at present, the CWBR is planning for a most secure financial future with very innovative tools.	2
Regional planning (UNESCO 2008)	The CWBR has an approved Framework Plan, based on bioregional principles, that includes a system of Spatial Planning Categories across all three zonation elements. The final CWBR Framework Plan was adopted in 2010 by the Cape Winelands District Municipality as biosphere reserve custodians and provides detailed spatial guidance for future land-use management.	3

Component	Descriptive results	Rating ^{24/33}
	<p>The Plan is integrated into spatial planning documentation of relevant municipalities.</p> <p>However, there is concern about ad hoc urban development on rural land that tends to erode the unique character of the area.</p>	
<p>Management framework (Ervin 2003, Hakizumwami 2000, Hockings, Stolton & Dudley 2000, Pasquini 2003, Pressey & Taffs 2001, Stoll-Kleemann & Job 2008, UNESCO 1996, 2002)</p>	<p>The CWBR does not have a management framework, although it is a high priority on the agenda of the management entity.</p> <p>The biosphere reserve is currently being championed by private persons in a voluntary capacity, albeit with strong administrative support from the Winelands District Municipality.</p> <p>The CWBR Company currently has no permanent staff members and no dedicated office space.</p> <p>The biosphere reserve has a clearly defined vision and objectives.</p>	1
<p>Legislation and government support (Dudley <i>et al.</i> 1999, Hakizumwami 2000, Stoll-Kleemann & Job 2008)</p>	<p>Presently the biosphere reserve concept in SA is being legislated using a soft law approach. It is not embedded in the Protected Areas Act, therefore no national legislative support. The Western Cape has a provincial biosphere reserves act that will be an enabling act on processes, funding and drafting of framework plans.</p> <p>Designation with UNESCO should result in national legislation, but do need to retain the flexibility. Too little support from government. Need buy-in from national government, also financial support to biosphere reserves. Biosphere reserves need to be given “teeth” to implement the principles.</p>	1
<p>Partners/Stakeholders (Hakizumwami 2000, Queensland Parks and Wildlife Service 2002, UNESCO 1996, 2002)</p>	<p>Strategic partners are represented in the management entity of the CWBR. However, many people are still not aware of the existence of the CWBR. Collaboration with partners and stakeholders is still a problem due to the recent designation of the biosphere reserve. Local communities still need to be convinced of benefits of the CWBR.</p>	2
<p>Threats/Challenges (Dudley <i>et al.</i> 1999, Pasquini 2003, UNESCO 1996, 2002)</p>	<p>Population growth and resulting urban sprawl pose a huge challenge.</p> <p>Direction on dealing with changes should be incorporated into the planned management framework.</p> <p>People are not really aware of sustainable development issues and their interconnectedness with the natural environment. Also too little benefits for local communities and private landowners.</p> <p>Lack of secure monetary resources is a pressing problem. The need for greater collaborative management has been identified as a challenge, thus more buy-in from stakeholders is needed.</p>	2

7. Discussion

The statements “a biosphere reserve is about people” (Holmes 2010) and “biodiversity is priceless” (Johnson 2010) sum up the aspects to be incorporated in biosphere reserve implementation. In order to be successful, a biosphere reserve needs to give a voice to all levels of society. This could sometimes be very problematic. Even in South Africa, striving to be a true rainbow nation, it should be possible to obtain “unity despite diversity” (Johnson 2010) when society supports the same long-term vision for the region in which they reside. One of the issues highlighted by all interviewees is the need for a widely supported biosphere reserve vision and objectives. As noted by Schliep and Stoll-Kleemann (2010), an understanding of the key objectives of the MAB Programme and of an individual biosphere reserve, could make a difference in such a “*multi-stakeholder decision-making process*”. They mention that biosphere reserve coordination is “*highly dependent on the ability of experts to communicate the programme’s objectives to all concerned*”.

Considerations on how best to use existing legislation in furthering biosphere reserve implementation find specific relevance in the case of the CWBR. This biosphere reserve had its origins in spatial planning processes, guided by national and provincial planning legislation, particularly the Municipal Systems Act and the Provincial Land Use Planning Ordinance.

In the section on integrated development planning as contained in the Municipal Systems Act, it is stated that municipal planning must be developmentally oriented. The Act prescribes the drafting of an integrated development plan for each municipality which is very much developmentally oriented according to section 26. It also stipulates a spatial development framework that would form the basis for land-use management in the jurisdictional area of the municipality. The integrated development plan guides all planning and development within a municipality.

The aim of the Land Use Planning Ordinance (1985) is to regulate land-use planning throughout the Western Cape Province and it provides guidelines in relation to drafting of structure plans by local authorities. It grants a local authority the option to submit a structure plan for land within its area of jurisdiction that will guide spatial development of the area to which it relates. The opportunity then exists for a local authority to have such a structure plan approved by the provincial powers that be under section 4 (6) of the Ordinance as a plan that needs to be adhered to for the following 10 years. In the Western Cape Province, structure plans are being drafted according to bioregional planning principles as contained in the bioregional planning guidelines of the Province (Department of Planning, Local Government and Housing 2000). These plans provide a sound basis for drawing up the framework plan required by biosphere reserves.

According to the Constitution of South Africa (1996) municipalities should *inter alia* “*promote social and economic development*” and also “*promote a safe and healthy environment*”. Municipalities are the most prominent service providers to residents and their functions range from environmental services such as clean water, to social services such as education and housing. Municipalities are therefore involved in a delicate balancing

act to satisfy all taxpayers (residents and businesses) while protecting the environment. Because biosphere reserves are subject to political conflicts and changes in political interests (Isacch 2008, Johnson 2010, Stoll-Kleemann 2005), constant political fluctuations also add to the complexity of the situation. A biosphere reserve could play a positive role in providing municipalities with a widely accepted framework within which decisions could be justified (Johnson 2010). The biosphere reserve vision and management framework project across political dispensations and could be used to train politicians and decision-makers in the basic concepts of sustainable development.

The biosphere reserves in the Western Cape Province will not be without teeth in future land use decisions. The Western Cape Biosphere Reserve Act (Government Gazette Extraordinary 6936 of 13 December 2011) stipulates in Section 6(g) that “all land uses and land use plans within a biosphere reserve must comply or be consistent with the framework plan concerned.”

8. Conclusion

The biosphere reserve concept is difficult to implement, and sometimes even to comprehend, because of the innate, inbuilt flexibility of the concept itself, which has to address aspects of various biological and sociological issues. Ironically, this flexibility and the many other facets associated with biosphere reserves, provide the reason why the concept is ultimately so successful.

Many people still confuse a biosphere reserve with a type of conservation area (Stoll-Kleemann & Welp 2008) and thus regard the conservation function as the most important, which is factually incorrect. Some groupings of society would consider a biosphere reserve a green tool with which to fight unwanted developments. On the contrary, other interest groups would promote so-called sustainable residential developments on the basis of its location within a biosphere reserve.

Given the multifaceted nature of the biosphere reserve concept, it is essential in the South African dispensation for a biosphere reserve to be fully accepted and supported by all relevant role-players, including politicians in power. It is, however, a well-proven policy that biosphere reserves need to be managed in a non-political manner to ensure continuity beyond political terms of office. It was mentioned that “green” issues are not a political mobilizing factor and are not to be seen as having political advantages (Johnson 2010, Stoll-Kleemann & O’Riordan 2002); nonetheless political buy-in is needed for a biosphere reserve to have the intended impact. In the Cape Winelands power of government alters between the national reigning party, the African National Congress (ANC) and the main opposition party, the Democratic Alliance (DA). Both have environmental policies that differ in their approach to environmental issues of concern. The environmental policy of the ANC projects a humanitarian point of view towards the environment. Its broad policy statement reads *“The ANC believes that all citizens of South Africa, present and future, have the right to a safe and healthy environment, and to a life of well-being. The broad objective of our environmental policy will be to fulfil this right. In this context, growth and development within South Africa will be based on the*

principles of sustainability” (ANC 2011). The DA’s approach to environmental management is grounded in a document “*In-trust-for-the-nation*” (DA 2009). This document refers in much detail to the need for a well-managed environment. The vision statement starts with “*the sustainability of the South African economy and our efforts at creating new opportunities for our citizens relies on the sound management of our environment and energy economy for both the current and future generations.*” Whereas the DA promotes a spirit of responsible, custodian care towards the environment, the ANC supports a more human-centered approach with focus on equitable access to resources (both renewable and non-renewable) and public participation in management of resources. Mention is being made of the objective to eliminate the negative environmental impact of the past apartheid regime. In a position paper on South African biosphere reserves, the lack of political interest and support was noted as a challenge to implementation of the biosphere reserve concept (South African Biosphere Reserve Working Group 2008). Therefore each biosphere reserve needs to position itself thus that it finds an affinity with the political powers and their decision-making structures.

The biosphere reserve concept is being dealt with nationally as a support mechanism to the system of protected areas. National government has drafted a protected areas expansion strategy wherein biosphere reserves are being referred to as conservation areas because they are not formally proclaimed in terms of protected areas legislation. Conservation areas are recognized as an important complementary mechanism for achieving national conservation objectives (Department of Environmental Affairs and Tourism 2007).

While it is important to note the different political approaches to environmental issues and the general misconception of biosphere reserves as merely conservation areas, it is crucial to market the biosphere reserve concept as a sustainable social-ecological land management tool. The value of using the biosphere reserve concept lies in its ability to inclusively stretch beyond biodiversity conservation by giving equal priority to socio-economic issues (Stanvliet & Parnell 2006). Thus, if carefully executed, the biosphere reserve concept does have a future in the South African context as a support mechanism to the protected areas expansion strategy.

This intrinsic value of the biosphere reserve concept is being realized through the CWBR. Although still in its early stages, the CWBR has the potential to become a well-managed multidisciplinary tool that will guide future land management decisions in support of sustainable development.

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5



Protecting Bia Biosphere Reserve for Improved Biodiversity Conservation in Ghana

Proteger la Reserve de Biosphere de Bia en Vue de L'amelioration de la Conservation de la Biodiversite au Ghana

EMMANUEL SALU¹

Abstract

The Bia Reserve was created in 1935 and named after the Bia River which drains the area. It is located in the Juabeso and Bia Districts of the Western Region of Ghana near the Ivory Coast border on an elevation between 170 and 240 meters above sea level. The vegetation is moist evergreen and moist semi-deciduous forest.

Intensive cocoa farming destroyed much of the original vegetation in the reserve. In 1974, it became an official national park and since 1975, no human activity like farming or logging has taken place. In 1985, the park was declared both a biosphere reserve and a UNESCO World Heritage site.

Bia Biosphere Reserve fulfils the three basic functions of biosphere reserves which are mutually reinforcing, namely:

- contributing to conservation of landscapes, ecosystems and genetic variety;
- contributing to socio-cultural ecologically sustainable development; and
- supporting scientific research, education and information exchange.

UNESCO's project named "Biosphere Reserves for Biodiversity Conservation and Sustainable Development in Anglophone Africa" (BRAAF 1995–1999) promoted snail and mushroom farming in the buffer zone to reduce pressure on the park's resources in line with the needs of the local population. Corn mills for processing cassava were donated to Kwamebikom and Adjoafua around the core zone for income generation.

Through the awareness seminars in the reserve, the local communities became aware of protecting the forest and the animals. The Protected Areas Development Project funded by the European Union, promoted NGO volunteer work and the formation of community resource management areas (CREMAs).

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Inventories of plant species and eco-physiological studies were carried out in the reserve. There is the need for the re-delineation of the buffer zone to ensure complete protection of the core area.

Keywords: Biosphere reserve; Bia; Ghana; conservation; information; education

Resume

La réserve de Bia a été créée en 1935 et tire son nom du fleuve Bia qui se jette dans la zone. Elle est située dans les provinces de Juabeso et de Bia de la région Ouest du Ghana, à côté de la frontière avec la Côte d'Ivoire à une altitude de 170 à 240 mètres au-dessus du niveau de la mer. La végétation est composée d'une forêt humide d'arbres à feuilles persistantes et semi-caduques.

L'agriculture intensive de cacao a détruit une grande partie de la végétation originale de la réserve. En 1974, elle a été classée officiellement comme parc national et depuis 1975, aucune activité humaine de style agriculture ou abattage des arbres n'a eu lieu. En 1985, le parc a été classé comme réserve de biosphère et site du patrimoine mondial de l'UNESCO.

La réserve de biosphère de Bia remplit les trois fonctions fondamentales des réserves de biosphère qui se renforcent mutuellement à savoir:

- contribuer à la conservation des paysages, écosystèmes et variétés génétiques;
- contribuer au développement durable de l'environnement socioculturel; et
- soutenir la recherche scientifique, l'éducation et le partage d'informations.

Le projet de l'UNESCO intitulé 'Réserves de biosphère pour la conservation de la biodiversité et le développement durable en Afrique anglophone' (BRAAF 1995–1999) a encouragé l'élevage d'escargots et la culture de champignons dans la zone-tampon en vue de réduire la pression sur les ressources du parc en harmonie avec les besoins de la population locale. Des dons de moulins pour le traitement du manioc ont été remis aux zones de Kwamebikom et Adjoafua entourant la zone centrale pour générer des revenus de subsistance.

Par le biais de séminaires de sensibilisation dans la réserve, les communautés locales ont pris conscience du besoin de protéger la forêt et les animaux. Le Projet de développement des zones protégées financé par l'Union européenne, a encouragé le travail des volontaires d'ONG et la formation de zones de gestion des ressources communautaires (CREMA).

Des inventaires d'espèces végétales et des études écophysiologicals ont été effectuées dans la réserve. Une redéfinition de la zone-tampon pour assurer la protection complète de la zone centrale est requise.

Mots-clés: Réserve de biosphère; Bia; Ghana; conservation; information; éducation

1. Introduction

The Bia Reserve was created in 1935 near the Bia River which drains the area. It is located in the Juabeso and Bia Districts of the Western Region of Ghana near the Ivory Coast border (Figure 1). It was demarcated from 1937–1939 and in 1940 the status was raised to the level of a reserve for timber resources and the protection of the watershed system between the Bia River and Manzan River which flows into the larger Komoe River in La Côte d'Ivoire. It lies between latitude 6° 20' to 6° 38' N and longitude 2° 58' to 3° 58' W, between the Sukusuku Forest Reserve to the west and Bia Tawya Forest Reserve to the South (Figures 2 and 3). Both of these Forest Reserves have been encroached and are now cocoa farms. Thus Bia is an ecological island of forest in a sea of cocoa.

Bia Biosphere Reserve covers 306 km² and is composed of a core area, Bia National Park (77.7 km²) in the North, the adjoining Bia Resource Reserve which is the buffer zone (227.9 km²) in the South, and a transition zone of 837 km². The area is generally flat with elevations ranging between 168 m near Manso Camp, and about 238 m at Radio Hill (Figure 2).

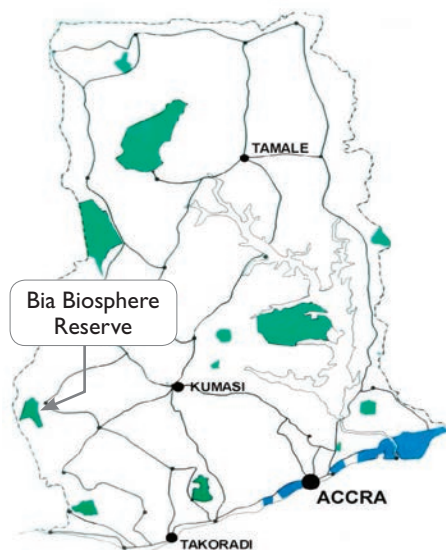


Figure 1: Map of Ghana showing Bia Biosphere Reserve

1.1 Climate

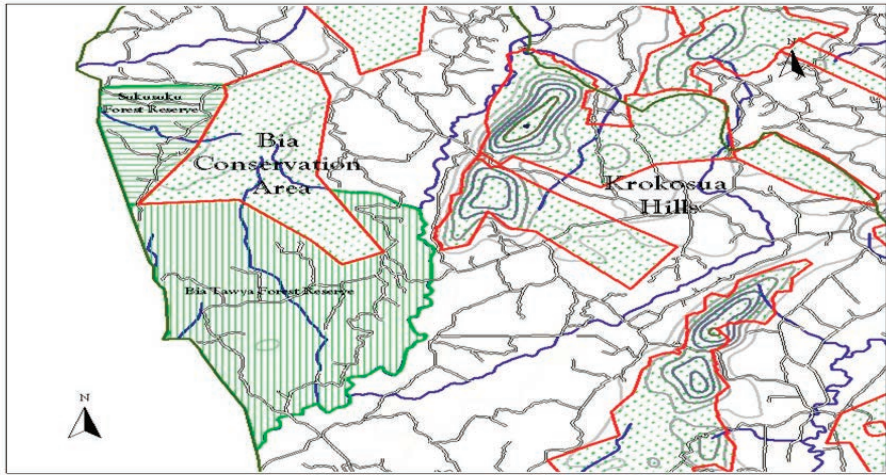
The climate has a bi-modal rainfall with the main rains in May–June and in September–October. The annual rainfall is 1 500 to 1 800 mm. Mean monthly temperatures are 24°C to 28°C. Relative humidity is high—between 90% at night and 75% in the afternoon. In the dry season, December to early March, the dry Harmattan winds blow from the Sahara.

1.2 Geology and soils

Bia Biosphere Reserve is within the Lower Birimian series which dominates the Ghanaian forest zone. It is composed of phyllites, schists, and greywacke with granite outcrops “Apaso” which means ‘opening’. The soil is Forest Ochrosol, typical of high forest areas with less than 1 500 mm rainfall per year. It is a slightly acidic soil with pH of 6–7 and reddish brown appearance (Benneh & Dickson 1988).

1.3 Vegetation

Bia lies in the transition zone between the Moist Evergreen Forest zone in the south and Moist Semi-deciduous zone to the north. Swampy areas are found in the forest. Bia’s



Environs of Bia



0 10 20 Miles

Figure 2: Map showing Bia, Krokosua and Sukusuku forest reserves

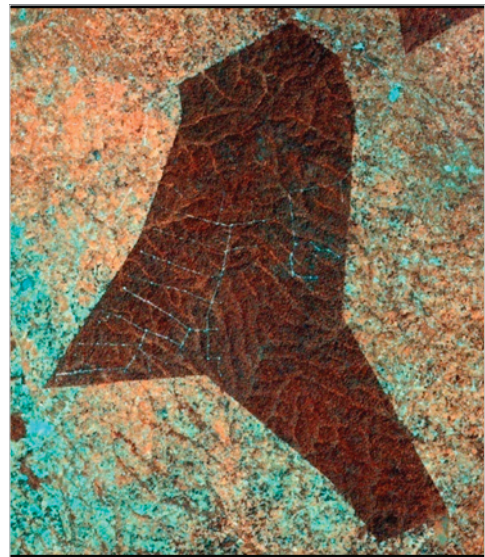
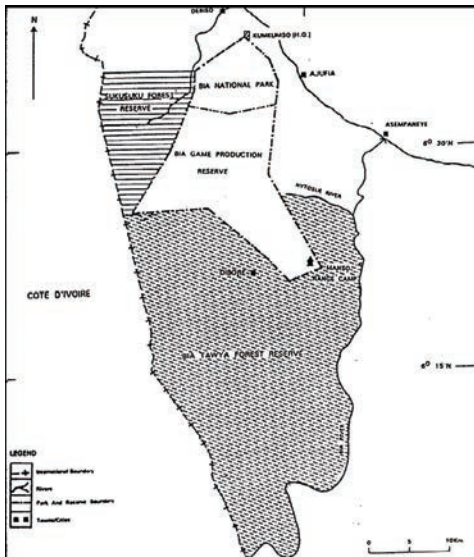


Figure 3: Map of Bia Biosphere Reserve

high rainfall and fertile soils has resulted in some of the tallest trees in West Africa with some over 60 m tall. In terms of species diversity or rarity however, Bia's flora is less spectacular (Hall & Swain 1981). The ten most common trees in Bia are *Chrysophyllum* spp., *Corynanthe pachyceras*, *Pycnanthus angolensis*, *Piptadeniastrum africanum*, *Celtis* spp., *Triplochiton scleroxylon*, *Nesogordonia papaverifera*, *Terminalia superba*, and *Dialium aubrevillei*. Emergents are dominated by species of Sterculiaceae (*Pterygota macrocarpa*, *Triplochiton*), Ulmaceae (*Celtis* spp.), *Ceiba pentandra*, *Entandrophragma* spp., and *Terminalia superba*. Openings in the forest canopy are often occupied by the invasive alien *Chromolaena odorata* (Acheampong weed).

The forest guard, who took the National Man and Biosphere Committee members to Bia Biosphere Reserve, confirmed that the best sections of closed forest are between Colobus Camp and Chimps' Camp on the boundary path between the core area and the buffer zone.

2. Problem statement

Since the 1940s the forest was harvested at an annual rate of 5% and large tracts of forest resources were lost. From 1956 to 1998 intensive logging took place in Bia Biosphere Reserve. Intensive cocoa farming destroyed much of the original vegetation. In 1974, it became an official national park and since 1975, no farming or logging has taken place. In 1985, the park was designated both a biosphere reserve and a UNESCO World Heritage site. The Ghana Wildlife Division of the Forestry Commission under the Ministry of Lands, Forestry and Mines is strategizing to keep the designated biosphere reserve intact. The National Man and Biosphere Committee in Ghana is supporting efforts to improve the situation.

3. Objectives of research

The aim of the research was to find out some of the practical benefits gained from Bia Biosphere Reserve and determine the way forward to achieving the goals of the reserve.

4. Methods

This study involved a desk top study of available literature, visit of the National Man and Biosphere (MAB) Committee to the area where interviews were held with the communities in the area and a personal study tour of the reserve and the communities for interviews, sampling and investigation of issues.

5. Research findings

The literature shows that the basic functions of biosphere reserves include:

- contributing to conservation of landscapes, ecosystems and genetic variety;
- contributing to socio-cultural ecologically sustainable development; and

- supporting scientific research, education and information exchange (UNESCO 1996).

Bia Biosphere Reserve fulfils these three basic functions of biosphere reserves which are mutually reinforcing.

5.1 Contributing to conservation of landscapes, ecosystems and genetic diversity

The vision for Bia Biosphere Reserve is protection of the rainforest biodiversity, to maintain ecological integrity, to encourage rainforest research, and the development of tourism. By the end of the year 2020 it is planned that Bia Biosphere Reserve will be well protected, with effective law enforcement and increasing animal populations. The Protected Area Management Advisory Board (PAMAB) will meet and improve the partnership between Bia Biosphere Reserve and the communities. Bia Biosphere Reserve will support and educate local communities and CREMA members to use resources sustainably. The staff will be well managed and adequately equipped. A foundation for tourism development will be prepared, within the district and beyond.

5.1.1 Genetic variety

The forest holds viable populations of large mammals, such as the Forest Elephant, Bongo, Leopard, and Yellow-backed Duiker.

The presence of seven primates (Table 1) was confirmed by the West African Primate Conservation Action (WAPCA) in 2009 (Gatti 2009, McGraw 2005).

Table 1: List of seven primates present in Bia Biosphere Reserve

Western chimpanzee	<i>Pan troglodytes verus</i>	
Olive colobus	<i>Procolobus verus</i>	Confirmed
Lowe's monkey	<i>Cercopithecus campbelli lowei</i>	Confirmed
Spot-nosed monkey	<i>Cercopithecus p. petaurista</i>	Confirmed
Bosman's potto	<i>Perodicticus potto</i>	Confirmed
Demidoff's dwarf galago	<i>Galagoides demidovii</i>	Confirmed
Western black-and-white colobus	<i>Colobus vellerosus</i>	Confirmed

Other very rare mammals of restricted range within Ghana include the Water Chevrotain (*Hyemoschus aquaticus*) and Giant Pangolin (*Smutsia gigantean*). Studies of rodents and bats (PADP 1998), showed a high diversity in the Resource Reserve and along forest edges. It is expected that new species could be added to the list of bats if canopy collection is applied. There are over 200 bird species, including Red-fronted Parrots, Wood Hoopoes, Tessmann's Flycatcher, Red-chested owlets and the Serpent Eagles. More than 650 butterfly species have been seen in Bia.

5.1.2 Wildlife numbers

Two systematic transect surveys of the large mammals of Bia were carried out in 2007 and 2009 and was estimated that there were about 135 elephants in Bia in 2009 (Danquah 2009). The population estimates appear to be increasing, although it must be emphasised that the confidence intervals on the data are wide, with the exception of bushbuck which is 93% confident. The Danquah survey showed that elephants, bongos and all “medium sized” mammals in Bia were spreading over a wider area probably because they were less harassed by poachers. Leopards, African civet and palm civet, blotched genet, slender and marsh mongoose, cusimanse, and the African clawless otter are present.

5.1.3 Endangered mammals

The IUCN Red List of Threatened Species (IUCN 2009) lists eight species which are present in Bia Conservation Area. These are listed in order of “Red List” status in Table 2.

Table 2: IUCN Red listed species present in Bia Conservation Area

Common name	Scientific name	Red List status
Chimpanzee	<i>Pan troglodytes</i>	Endangered
Olive colobus	<i>Procolobus verus</i>	Near threatened
Giant pangolin	<i>Smutsia gigantea</i>	Near threatened
Elephant	<i>Loxodonta africana</i>	Near threatened
Leopard	<i>Panthera pardus</i>	Near threatened
Tree pangolin	<i>Phataginus tricuspis</i>	Near threatened
Bongo	<i>Tragelaphus euryceros</i>	Near threatened
Black & white colobus	<i>Colobus vellerosus</i>	Vulnerable

5.1.4 Birds

Over 203 different species of birds were recorded by ornithological surveys in Bia National Park and Resource Reserve (Dowsett-Lemaire & Dowsett 2005). Eight globally threatened species were recorded at Bia, but the White-breasted Guineafowl (*Agelastes meleagrides*) was last seen in 1953 and is considered extinct. The Green-tailed Bristlebill (*Bleda eximius*) is rare at Bia. Four species are in the “Near Threatened” category: Hartlaub’s Duck (*Pteronetta hartlaubi*), the large hornbills (*Bycanistes cylindricus* and *Ceratogymna elata*) (no records since 1991) and the rare starling (*Lamprotornis cupreocauda*). It is possible that the large hornbills were exterminated by hunting; they are subject to local movements following fruiting opportunities and could come back if protection were reinforced. Data are deficient on the bulbul (*Phyllastrephus baumanni*) and the flycatcher (*Muscicapa tessmanni*) which has one of the most beautiful songs of any forest bird. It is not uncommon at Bia.

5.1.5 Reptiles

There is little information on reptiles but Bia may hold pristine reptilian fauna. Confirmed reptiles include ten species of snake, Nile Monitor (*Varanus niloticus*), Common hinged Tortoise (*Kinixys erosa*) and Broad-fronted Crocodile (*Osteolaemis tetraspis*) (MES 2002).

5.1.6 Amphibians

Being the least known vertebrate group of Bia, the amphibian list may be vastly increased if experts are brought in or encouraged by the Wildlife Division. Tree frog diversity in particular is believed to be very high, due to the permanently high humidity, relatively high up in the closed canopy. It is not unrealistic to expect that detailed surveys and canopy collection may produce some new species to science.

5.1.7 Fish

During the 2009 survey of Bia's ichthyofauna, the pools in the protected area were almost dry, hot, muddy and disturbed by the activity of elephants. They nevertheless contained 16 different species. Two, *Sarotherodon galilaeus multifasciatus* and *Epiplatys chaperi* were endemic to the Eburneo-Ghanaian ichthyofaunal region. Both are ecologically tolerant and widespread within the region.

Two other species, *Clarias buettikoferi* and *Barbus bigornei*, had not been previously recorded from Ghana and are ichthyofauna elements of Upper Guinea and the Eburneo-Ghanaian region. All other species (perhaps with the exception of an unidentifiable *Barbus* specimen) belong to the Sahelo-Sodanian ichthyofaunal region (MES 2002).

5.1.8 Invertebrates

Little is known of the incredible diversity of invertebrates expected in Bia, thus this is a task for future research. This research will discover many species hitherto unknown to science. Butterflies have been studied to some extent. Ghana has a total butterfly fauna of almost 900 species (EPA 2004). This constitutes 90% of all butterflies known from west of the Dahomey Gap, an important bio-geographical feature that separates the westernmost African rainforests from the main equatorial rainforests. The bulk of these 900 species are pure forest butterflies with a varying degree of tolerance of forest degradation. As such, butterflies are often cited as an indicator of forest health and biodiversity. Very few butterfly inventories exist for any part of West Africa. The few studies done (Larsen 2001, 2006) identify Bia as one of the most important remaining forests for butterflies in Ghana. So far 404 species were documented in Bia and the estimate was 652 species representing 73% of the known butterfly species in Ghana.

5.1.9 Conservation of landscapes and ecosystems

From 1956 to 1998 there was intensive logging throughout Bia Biosphere Reserve. While this has resulted in lower forest biodiversity, it is noticeable that some wildlife species seem to prefer the logged areas. This is because there is more grazing in the secondary forest as a result of the openings in the canopy. Since 1998 natural regeneration has been

taking place. Tracks, trails and the boundary have been cleared regularly. There has been no planting of trees or other vegetation management.

5.2 *Contribute to socio-cultural ecologically sustainable development*

5.2.1 Social

The best way of seeing Bia Biosphere Reserve is by walking in the forest with a forest guide. The guides follow seven different set trails along paths to avoid getting lost. These walks last between one and two hours. Forest animals are difficult to see due to the dense vegetation but visitors will hear calls from many species, including monkeys, which can sometimes be seen in the canopy jumping from tree to tree. The guided forest walks should be improved. During these walks the history of Bia could be explained, trees and plants with medicinal values and other properties pointed out, as well as types of trees present in the area.

5.2.2 Cultural

There are no known archaeological sites in Bia Biosphere Reserve. The rocky outcrop near Kunkumso called 'Aposo' is considered sacred, due to the dwarfs (spirits) that are said to inhabit the place (Figure 4). It was discovered by the ancestors of the Debisohene. It is said that the two small pools in the rock never dry up, and sacrifices and gifts are offered there. There has been no permanent human habitation. There were only some temporary hunters' camps when the area was gazetted. However the policy is that if people want to visit the site they may request permission and if any relic is found the advice of the National Museum and Monuments Board should be sought.



Figure 4: MAB Committee members sit on 'Aposo' and listen to the history of the area

5.3 *Support scientific research, education and information exchange*

5.3.1 The Man and Biosphere (MAB) programme

The MAB Young Scientist award was instituted by UNESCO to encourage young scientists from developing countries to use MAB biosphere reserves as project sites in their research and to encourage those who already use such sites to undertake comparative studies in other sites. Annually a call for proposals was placed in the Daily Graphic and Ghanaian Times. Various research areas were covered including 'Frugivores and fruit removal of *Antiaris toxicaria* (Moraceae) at Bia Biosphere Reserve' (Kankam & Oduro 2009) and 'Ecology and status of the giant African snail in the Bia Biosphere Reserve in

Ghana' (Asamoah 2009). Other research covers elephant population research, primate species monitoring, studies on the giant African snails, and community-based management of natural resources.

In response to the 2010 call for proposals, 22 applications were received for the 2011 award. After screening, four were selected for Songor and Bia and submitted to UNESCO. The topics selected by the National Committee for Bia Biosphere Reserve were 'Assessment of the direct and indirect potential contribution of REDD + payments on local livelihoods'; 'Bat congruence in ecosystem management and biodiversity conservation'; and 'Effects of selective logging on biodiversity'. These show the value students attach to such research initiatives.

5.3.2 Inventory of plant species

Inventories of plant species and eco-physiological studies were carried out in the biosphere reserve by the BRAAF project. About 640 species of vascular plants were identified during the 1999 survey. There is the need for re-delineation of the buffer zone of the biosphere reserve to ensure complete protection of the core area.

5.3.3 Bird watching

Bia Biosphere Reserve could be used for organised bird watching tours, because there are a variety of forest birds which are possible to see because of the clearings in the canopy. Access to Bia is relatively easy and normally there is no disturbance by other tourists. It is, however, important to provide the bird checklist, request all birders to report any new species they have found, and make available binoculars and reference books on how to identify birds.

5.3.4 Picnic sites

New picnic sites have been built. They are equipped with benches and tables. There is no charge for the use of picnic sites, only entrance fees. The use of these sites should be encouraged both locally and internationally through marketing efforts.

5.3.5 Bia Research Centre

The Bia Research Centre was built by PADP I (2001) and fully renovated by PADP II (2007). Universities such as the Kwame Nkrumah University of Science and Technology have expressed an interest in upgrading the Research Centre. The new University of Natural Resource Management to be established in the Brong Ahafo Region can take advantage of this facility. The policy is to make full use of the Bia Research Centre. The research centre is a good venue for staff training of the Wildlife Division. The Research Centre can be used by university students for field courses and by groups of independent researchers. The management of the Centre can apply for funds to equip the centre from the Natural Resource and Environmental Governance (NREG) Programme which is a multi-donor budget support fund for conservation and protection of the environment.

5.3.6 Current and future research priorities

Research on chimpanzees by A Rocha is currently ongoing as a continuation of the mammal survey, which should be encouraged. Research is a very important use of Bia and deserves the support of the authorities.

Research projects that would be useful to the biosphere reserve are the following: (i) Repeat the large mammal survey in order to monitor trends; (ii) The distribution and abundance of chimpanzees, and chimpanzee habituation for tourism; (iii) The effect of logging on wildlife distribution; (iv) The effect of water availability on biodiversity; (v) Attractions in Bia for tourism development; (vi) Dynamics of law enforcement, survey of hunters around Bia; and (vii) Community response to conservation initiatives.

The Management should ensure that researchers deliver their reports to the reserve authorities and to the Wildlife Division head office library. They should also try to build capacity of their counterparts in Bia. There should be efforts to ensure that the researchers work with counterparts from among Bia Biosphere Reserve staff for information exchange.

6. Conservation measures

Several conservation measures have been taken regarding fire management. There have not been major fires to date, only a small fire occurred near Apaso in 2006. Efforts are being made to educate communities and staff on the dangers of fire. Staff of the Wildlife Division annually clears the forest boundary line to serve as a fire break at the start of the dry season. The staff also monitor and report on fire risks and tree hyrax hunting. The communities have been advised to collaborate with the Ghana National Fire Service and fire volunteers during the dry season to prevent the occurrence of forest fires.

The protected areas are maintained as natural ecosystems with indigenous wild species. The main alien plant is *Chromolaena odorata* (Acheampong weed). It rapidly colonises disturbed areas such as logging tracks and loading bays. It is well established throughout the region and therefore cannot be controlled in the park alone as it would soon re-colonise from outside. The weed is being monitored to determine any spreading.

6.1 Wildlife management

The Ghana Wildlife Division believes that the most effective way of managing the wildlife in Bia is by effective law enforcement so that animal numbers can increase. Forest guards have been increased through new recruitment and training. The Wildlife Division has also increased the food rations given to the guards on duty. Water may be provided in protected areas in savanna to attract wildlife to places where it can be seen by tourists or to increase the carrying capacity of the area. In the south there is water in the loading bays left by the logging companies. In the dry season there is at times a water shortage in the north, so the animals move south. There has been a problem of animal management outside the park. There are frequent problems with elephants damaging crops around Bia, especially cocoa. The local people want protection and have complained to the staff. In the last few years some farmers at Kakum have successfully used

engine oil and chilli pepper on rags tied to ropes around the fields which helps to keep the elephants away. The engine oil/chilli pepper method has been tried at Bia with assistance from Wildlife Division staff from Kakum. Demonstration sites have been set up and shown to be effective. Adoption by farmers is still low. Many farmers want Wildlife Division to provide the materials. Some of them still hope for compensation and want elephants to be killed.

6.2 Farming and gardening

Farming in the biosphere reserve is illegal. Staff at range camps may grow vegetables or other non-invasive plants within 20 m of their backyard. The plants must be for their own use (not for sale). There is no compensation for loss or damage due to wildlife.

6.3 Community use of resources

The gathering of snails has been allowed under certain conditions, but has caused a lot of problems: the staff cannot match the number of people who want to collect snails; it diverts Wildlife Division's attention from its core business; people take advantage of permission to collect snails and set traps and hunt at the same time; there is littering with rubber bags and the creation of camps, among others. Snails have appeared in 2008, 2009 and 2010 (Figure 5). At two stakeholder meetings the PAMAB decided that snail collecting will not be allowed until further notice. It was agreed that snail collecting has been causing too many problems.



Figure 5: Snails from Bia Biosphere Reserve

There will be a workshop for all stakeholders to be organised by the District Assembly and Wildlife Division to discuss any future snail collecting and the regulations to be adopted. Wildlife Division's principle is that gathering of resources in the biosphere reserve is against park regulations, but may be allowed if the community can ensure that snails are sustainably managed and ensure that snail collecting does not create conflict. Snail collecting must not upset the ecological integrity of the biosphere reserve and all communities must agree to the same arrangements. The Park Manager must enforce these regulations.

6.4 Mineral prospecting and mining

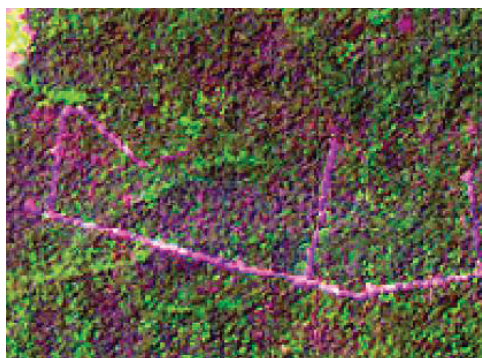
There is no illegal mining in Bia which lies to the west of the gold bearing areas. Mining and mineral prospecting are prohibited in National Parks and Reserves. Anyone caught prospecting for minerals should be instructed to stop or arrested if necessary.

6.5 Habitat restoration

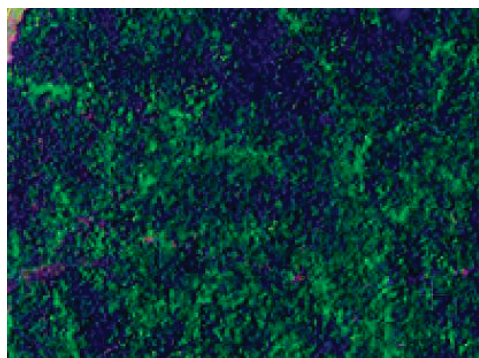
Formerly there were many kilometres of logging trails, and many loading bays until the logging stopped in 1999. The area is undergoing gradual re-colonising by natural

Protecting Bia Biosphere Reserve for Improved Biodiversity Conservation in Ghana

vegetation as shown by satellite images of exactly the same location south of Benkasa. The Wildlife Division has a policy to allow nature to re-colonise affected sites (Figure 6).



In 1998 these tracks were more than 20 m wide.



By 2003 the tracks were largely re-colonised.

Figure 6: Satellite imagery of the regeneration of forest reserve

6.6 BRAAF Project

The project was called UNESCO Biosphere Reserves for Biodiversity Conservation and Sustainable Development in Anglophone Africa (BRAAF 1995–1999). Bia was designated a biosphere reserve in 1983, and currently is one of only two biosphere reserves in Ghana (Songor Biosphere Reserve was designated in 2011). UNESCO funded a four-year MAB Programme in Bia starting in 1995. Led by the Environmental Protection Agency (EPA) and using experts from Wildlife Division, Botany Department of the University of Ghana



Figure 7: MAB Committee gets feedback from BRAAF project beneficiaries

and Kwame Nkrumah University of Science and Technology, various studies were undertaken in fauna, botany and social anthropology. The final report was submitted in 1999. The BRAAF project promoted snail and mushroom farming in the buffer zone to reduce pressure on the park's resource in line with the needs of the local population. Corn mills for processing cassava were donated to Kwamebikom and Adjoafua around the core zone for income generation. There has been little follow-up and the programme has had little impact on management of Bia Biosphere Reserve (Figure 7).

6.7 Awareness seminars

Through awareness seminars the local communities became aware of protecting the forest and the animals in the biosphere reserve. The Protected Areas Development

Project funded by the European Union promoted NGO volunteer work and the formation of community resource management areas (CREMAs).

6.8 Collaborative management

There are 42 communities around Bia Biosphere Reserve. There are four CREMAs with 34 Community Resource Management Committees (CRMCs), which are all in the north of Bia. Their livelihood comes from cocoa farming. Most people have welcomed the CREMA initiative and have been very supportive and have embraced the CREMA concept. Some other areas, such as Asuontaa would prefer to have CREMAs. However, some of the local people think that the CREMAs are for Wildlife Division, rather than for themselves. In an effort to try to address such issues, Wildlife Division has devised and is actively implementing the Collaborative Management Policy. The Policy of Wildlife Division is to support PAMAB in enabling local communities to contribute to the biosphere reserve management. It also supports CREMAs for sustainable resource use by communities around Bia and collaborate with NGOs, District Assemblies, and other stakeholders to support CREMAs in conserving their natural resources. The organizations which are protecting the area include the Protected Area Management Advisory Boards (PAMAB), Community Resource Management Areas (CREMAs), the District Assembly, Non-governmental Organizations (NGOs) and Traditional Authority.

6.8.1 Protected Area Management Advisory Board (PAMAB)

The objectives of PAMAB are to resolve conflicts relating to the biosphere reserve and the surrounding communities; to identify and integrate local people's concerns into biosphere reserve management; to collaborate with local people to try to ensure better management; to win local support for park management and wildlife; to advise on conservation-linked enterprises; to assist with integrating the biosphere reserve into the District planning system; and to promote appropriate traditional natural resource management practices. Membership of PAMAB include three chiefs from the local communities, two representatives from Wildlife Division, representatives from youth groups in the communities, two representatives from the two District Assemblies; one representative from the Police Service, one representative from the Fire Service, two farmers and other co-opted members. There were problems with funds for the organisation of meetings. It is agreed that Wildlife Division should support PAMAB activities (Figure 8).



Figure 8: MAB Committee held meeting with PAMAB members

6.8.2 Community Resource Management Areas (CREMAs)

A CREMA is “any geographically defined area outside a protected area which is endowed with sufficient natural resources, and where communities have organised themselves for the purpose of sustainable resource management”. The CREMA committee uses existing traditional community decision-making processes, and has an executive and a constitution to regulate and guide its activities. Its constitution is legitimised by a District Assembly by-law. The first CREMA established was from Amokwaw and then other CREMAs were formed (Figure 9). The activities for each CREMA depend on their objectives stated in their constitution, but will regulate hunting of wildlife; help improve livelihoods and support development in the local communities; advise Wildlife Division on licenses to trade in wildlife products; help resolve animal conflicts or other resource conflicts; reduce poaching in the biosphere reserve by allowing controlled hunting; collaborate with other CREMA Committees in neighbouring areas; and promote awareness of wildlife conservation and management. The CREMA Committee controls and manages the CREMA. Their sources of income include sale of hunting licenses, fines, sale of non-timber forest products, membership registration, research and donations from organizations.



Figure 9: Inauguration of CREMAs for Kukumso and Debieso

6.8.3 The District Assembly

The function of the District Assembly is to enforce by-laws and the district biodiversity strategy, support infrastructural development, support the poverty alleviation programmes, support and monitor the natural resources and provide logistics for the CREMAs to do their work.

6.8.4 Non-governmental organizations and traditional authority

The NGOs are to help the CREMA executives to obtain funds where possible and to assist with natural resource monitoring. The chiefs in the areas help maintain peace and stability in the communities and help to discipline the CREMA offenders.

7. Lessons learnt from Bia Biosphere Reserve

The decision by government to make Bia a biosphere reserve and for UNESCO to designate it as such was a landmark step for conserving the ecosystems of the area. There is forest regeneration and genetic variety of flora and fauna present in the area, compared to intensive deforestation going on in the country.

Government institutions, development partners, civil society and the community leaders have played a strong role in managing the biodiversity of Bia for future generations. Researchers, students and tourists will benefit immensely from the rich biodiversity found in Bia Biosphere Reserve. However, there is data deficiency on particular mammals and birds which need to be corrected through future research.

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Biodiversity and the Sustainable Use of Natural Resources: the Case of the Mare aux Hippopotames Biosphere Reserve in Burkina Faso

Biodiversité et utilisation durable des ressources naturelles: cas de la réserve de biosphère de la mare aux hippopotames du Burkina Faso

JEAN-NOËL PODA, MAMOUNATA BELEM, OLLO THÉOPHILE DIBLONI, NESSAN DÉSIRÉ COULIBALY, AMADÉ OUEDRAOGO¹

Abstract

Since 1987, the *Mare aux Hippopotames* Biosphere Reserve constitutes an experiment within the framework of integrated and participative development policy with the National Land Management Programme (*Programme National de Gestion des Terroirs—PNGT*) and the National Office for Protected Areas (*Office National des Aires Protégées—OFINAP*).

The region is distinguished by two major characteristics related to natural resources and the management system which are at the root of the supply and demand of research:

- Great natural and agricultural potential;
- A changing environment due to strong migratory pressures, evolving production systems and the deterioration of natural resources.

The research activities that have been conducted for more than a decade aim to support conservation and the sustainable use of natural resources.

The results obtained on vegetation show a high percentage (61.7%) of Guineo-Congolese formations and indicate that the classified gallery forests of the Hippopotamus Lake and the Guineo-Congolese forest formations have many floristic similarities. They are considered to be a relic of former wooded formations. Through

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surveys and analysis of aquatic vegetation, it was discovered that the water courses are ascent paths for Guinean flora in the Sudanese region. These various chorological characteristics emphasize the originality of this flora which adapted to very special environmental conditions.

Results were obtained on ichthyological fauna, which comprises 37% of some hundred species of fish recorded in Burkina Faso; on birds, which are the best indicators of the environment's state and on hippopotami and land fauna which reveal the anthropogenic impact on various surroundings more effectively. With regard to socio-economic phenomena, results were obtained on the impact of agricultural practices, traditional stock farming and migrations on the natural resources.

The surveys revealed that the different socio-professional groups have multiple and various interests in the reserve. As far as the populations' resource needs are concerned, pastures are in fourth place, after medicinal plants, firewood and fish. In other respects, bush fires and excessive logging constitute the main causes of vegetation deterioration, whereas stock farming and agriculture are in third and fourth place, respectively. If the management plan within the context of the biosphere reserve concept is successful, it would serve as a model for the sustainable use of natural resources, preserving other endangered forests in the country.

Key words: Ecosystems, biodiversity, anthropogenic activities, biosphere reserve, Burkina Faso

Résumé

La réserve de la biosphère de la mare aux hippopotames constitue depuis 1987 une expérience à suivre dans le cadre de la politique de développement intégré et participative avec le Programme National de Gestion des Terroirs (PNGT) et l'Office National des Aires Protégées (OFINAP).

La région est caractérisée par deux faits majeurs en matière de ressources naturelles et de système de gestion qui sont à la base de l'offre et de la demande en matière de recherche:

- Les énormes potentialités naturelles et agricoles;
- L'environnement en mutation dû à une forte pression migratoire, à l'évolution des systèmes de production et à la dégradation des ressources naturelles.

Les activités de recherches conduites depuis plus d'une dizaine d'année visent à soutenir la conservation et l'utilisation durable des ressources naturelles.

Les résultats obtenus sur la végétation montrent un pourcentage élevé des formations Guinéo-Congolaises (61,7%) et indiquent que les galeries de la forêt classée de la mare aux hippopotames ont beaucoup d'affinités floristiques avec les formations forestières Guinéo-Congolaises. Elles constitueraient une relique d'une formation boisée dans le temps. L'inventaire et l'analyse de la végétation aquatique révèlent que les cours d'eau sont des voies de remontée de la flore guinéenne dans la région

soudanienne. Ces divers caractères chorologiques soulignent bien l'originalité de cette flore adaptée à des conditions de milieu très particulières.

Les résultats ont été obtenus sur la faune ichtyologique qui compte 37% de la centaine d'espèces de poissons répertoriés au Burkina Faso, les oiseaux qui sont les meilleurs indicateurs de la santé des milieux, les hippopotames et de la faune terrestre qui expriment mieux les impacts anthropiques sur les divers milieux. Sur le plan socio-économique des résultats ont été obtenus sur l'impact des pratiques agricoles, de l'élevage traditionnel, des migrations sur les ressources naturelles.

Les enquêtes ont ainsi révélé que les différents groupes socioprofessionnels avaient des intérêts multiples et divers sur la réserve. Ainsi les pâturages occupent le quatrième rang en besoin de service après les plantes médicinales, le bois de chauffe et les poissons. Par ailleurs, les feux de brousse et la coupe abusive du bois constituent les principales causes de dégradation de la végétation, l'élevage et l'agriculture occupant respectivement le troisième et le quatrième rang. Le plan de gestion dans le concept de réserve de biosphère, s'il réussissait, servirait de modèle d'utilisation durable des ressources naturelles pour sauvegarder les autres forêts menacées du pays.

Mots clés: Ecosystèmes, diversité biologique, actions anthropiques, Réserve de biosphère, Burkina Faso

I. Introduction

The dry spells which affected Africa's Sahalian regions (1910, 1914, 1940–1944, 1970–1974) had very serious economic as well as social consequences.

However, it was the great drought which ravaged the Sudano-Sahalian zone from 1968 and which worsened from 1972 to 1973 that emphasized the phenomenon of desertification and led the affected States and their partners to take measures such as:

- creating regional structures including the Permanent Interstate Committee for Drought Control in the Sahel (*Comité Permanent Inter-états de Lutte Contre la Sécheresse au Sahel* — CILSS) with its specialized institutes, increasing the number of representatives from the International Union for Conservation of Nature (IUCN) in Burkina Faso; reinforcing aid and interventions within the framework of bilateral and multilateral agreements relating to environment conservation and sustainable development;
- organising interventions by various non government organisations (NGOs) accompanying the State structures in the fight against poverty;
- boosting and reinforcing scientific and technical capacities for research on the environment and natural resource management.

Burkina Faso is a land-locked country without direct access to the sea. The country's climate is of a dry tropical type, with two distinct seasons: a rainy season and a dry season. The main environmental problem is essentially the deterioration of natural resources, due to clearing, overgrazing, poaching, soil erosion and desertification. In this rather sombre state of affairs, the biosphere reserves of UNESCO's Man And

Biosphere programme (MAB) fulfil a wide range of functions including local development, biodiversity conservation, training and research.

The fortieth anniversary of UNESCO's MAB programme 1971–2011 offers an opportunity to situate the contribution of the UNESCO/MAB programme in promoting the living environment of rural and urban populations, and more specifically, in scientific knowledge and sustainable management of natural resources, with Burkina Faso's Mare aux Hippopotames Biosphere Reserve as an example.

2. The classified forest of the Mare aux Hippopotames Biosphere Reserve

The Hippopotamus Lake's forest was classified by Decree no. 836 SE of 26 March 1937 classifying the Bansie, Bambou, Kapo, Bahon and the Hippopotamus Lake forests in the Bobo-Dioulasso area (Côte d'Ivoire). It stretches over 19 200 hectares and includes a permanent 660 hectare lake with a specific attraction. Situated in the Houet province, approximately 60 km north of Bobo-Dioulasso, between latitudes 11°30' and 11°45' N and longitudes 04°05' and 04°12'W, this forest is well-known due to the fact that its lake is a favoured habitat for hippopotami. The lake is frequented by tourists passing through Bobo-Dioulasso.

2.1 Development of the conservation strategy in Burkina Faso

The strategy for the conservation of genetic resources in Burkina Faso has taken on many forms. From 1936, several forests have been protected by legal classification texts. Decree No 836 SE of 26 March 1937, which classified various forests including the Hippopotamus Lake forest, is part of this series of texts. Later, in 1968, an order regarding wildlife conservation and hunting practices was given in Burkina Faso, which gave a definition to wildlife reserves (Spinage & Traoré 1984). The aim of the entire strategy was forest conservation and wildlife development. In the hunting areas, slaughtering or capturing fauna was prohibited unless the hunters had permission from the reserve's authorities or unless the authorities monitored the hunting activities. Habitation and other human activities were either prohibited or regulated.

Unfortunately, these protective measures were taken without real participation from surrounding populations who were frustrated because they felt that the state was denying them their best agricultural land and pastures. Due to this hostility, a number of these protected areas suffered various aggressions from the populations, including poaching, bush fires, agricultural clearing, grazing, etc.

After having been implemented for half a century, these authoritarian conservation strategies have provided rather disappointing results. Today, the majority of the protected areas are in a rather deteriorated state and are the subject of a development plan with the participation of the surrounding populations. The Mare aux Hippopotames Biosphere Reserve is the first biosphere reserve in Burkina Faso and constitutes an experiment within the framework of integrated and participative development policy.

The zone is formed from a relatively flat plain with an altitude varying between 300 and 320 m. It is divided into two by the Leyessa River, flowing from the Mouhoun River which forms the western boundary (Figure 1). The region's climate is of the South-Sudanese type, with an annual rainfall average of 1 100 mm and an average annual temperature of 28°C.

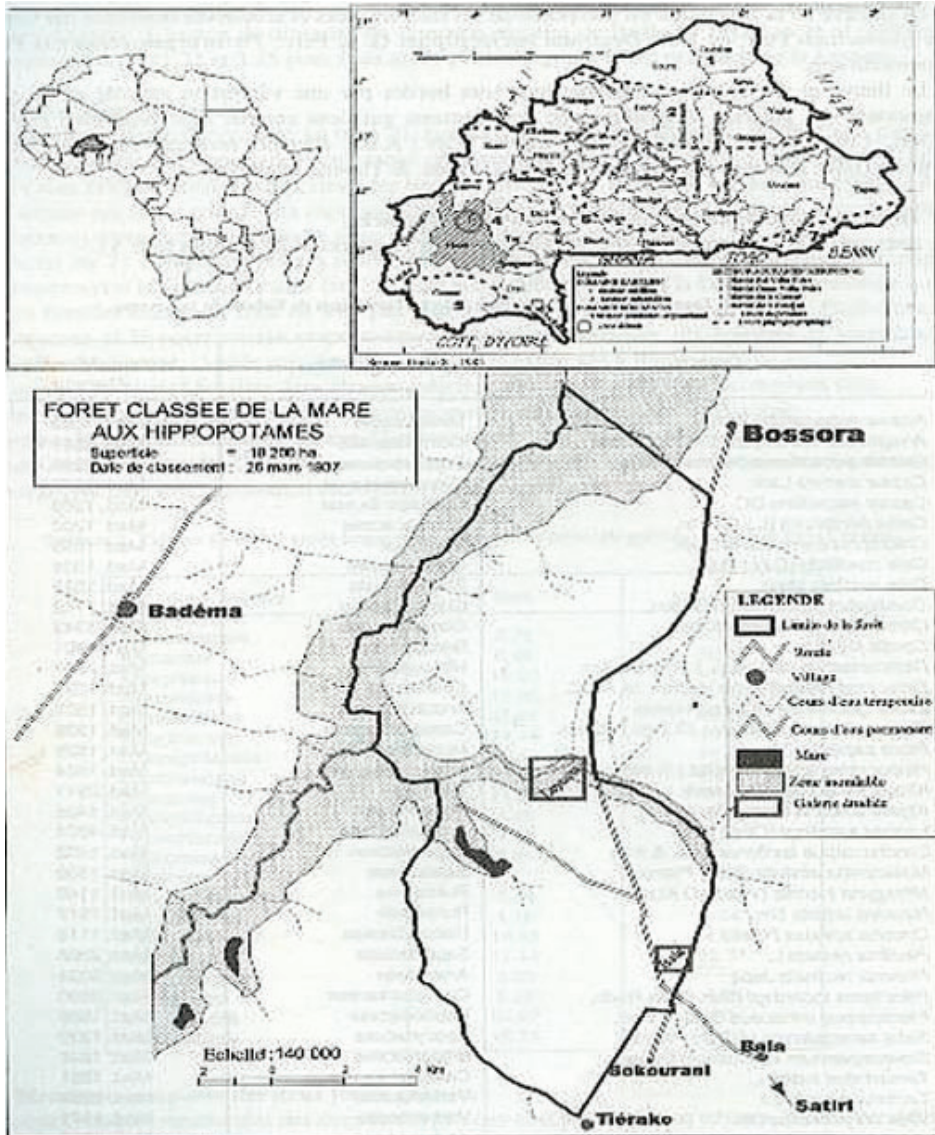


Figure 1: Location of the Mare aux Hippopotames Biosphere Reserve

The Hippopotamus Lake's classified forest contains an important part of the flora and fauna of two biogeographical regions: the Sudanese zone and the Sudano-Guinean zone

(Bognounou 1979, CNRST 1980). Among the 3 800 000 hectares of classified forests, wildlife reserves and national parks, this forest constitutes one of the best-preserved forests of Burkina Faso.

In order to counter the deterioration trends of natural resources and to preserve its protected areas which harbour fauna of world-wide interest, the biosphere reserve's site has received various types of support, including financing in the form of donations from the Global Environment Facility (GEF) through the World Bank. Owing to its ecological status (classified forest, Ramsar site and biosphere reserve), the zone has been the subject of several studies, of which the majority was concerned with hydraulic, wildlife, forest and piscicultural resources.

Given the needs of research and the participative protection of the natural heritage, the authorities of Burkina Faso repeatedly proposed that this forest be listed as a biosphere reserve (Bonkougou *et al.* 1984).

As UNESCO was convinced of the importance of the Hippopotamus Lake's forest in terms of conservation, interest for scientific knowledge and human values which it puts at the service of the region's integrated development, the organization accepted to list the area in the international biosphere reserve network in 1987. Due to its abundance of aquatic and terrestrial biodiversity, the Mare aux Hippopotames Biosphere Reserve has always received special attention for protection, research and development purposes. The approach was based on a wide national base, assembling representatives from:

- the local populations (customary leaders, village delegates, etc.);
- the administration (the prefect and leaders from local services);
- the ministries concerned (Environment and Water, Higher Education and Scientific Research, Planning, Tourism, Land Administration, etc.).

This cooperation aims to find practical strategies which would be applicable in a sustainable way, in order to resolve the complex socio-economic problems in the region. A dialogue between the different groups was established as it is necessary to integrate conservation and development.

The management programme that a biosphere reserve entails, aims to establish a closer relationship between the populations and local authorities than in the past.

The combined management of forests and land by the National Land Management Programme (Programme National de Gestion des Terroirs-PNGT) and the National Office for Protected Areas (Office National des Aires Protégées — OFINAP) is necessary for the following reasons:

- the management of natural resources is a challenge insofar as these resources suffer great pressures due to massive clearing;
- the remaining forest and fauna constitute a precious biodiversity heritage, but are also greatly threatened;
- the growing demand for firewood in Bobo-Dioulasso, the country's second-largest city, exerts increasingly strong pressures on the neighbouring natural forests;
- the land management activities which were launched in certain villages provided thoroughly encouraging results which are worth replicating;

- the biosphere reserve management plan constitutes a precious asset and tool for making a success of combined management.

In this manner, the Mare aux Hippopotames Biosphere Reserve constitutes an excellent means of integrating conservation and development by putting the local populations' participation and knowledge of sustainable ecosystem management to good use. From this point of view, the biosphere reserve increases the chances that the regional development programme will be successful in land management.

2.2 The research approach for scientific knowledge applicable to the sustainable management of natural resources.

The region is characterized by four major features relating to natural resources and the management system which are at the base of the supply and demand of research:

- Great agricultural potential,
- A changing environment due to strong migratory pressures on the natural resources,
- Great flora and fauna diversity,
- A need to adapt to climate change.

Research demands convey the preoccupations of the different research clients (producers, farming organisations, popular state services, NGOs).

In order to survive, the populations of the riparian villages (transition zones) rely on income diversification and complementary fauna and flora resources as alternatives. The resulting loss of biodiversity has reached disturbing proportions around the biosphere reserve, and the efforts aimed at reversing the current deterioration trends are limited by insufficient financing, a shortage of alternative resources for reducing the pressures exerted by the local populations and insufficient scientific capacities and basic data to accompany activities on the terrain.

The general theme of basic and applied research in the Mare aux Hippopotames Biosphere Reserve is therefore formulated in the following way (Maldague 1986):

“The knowledge of ecosystems and human activities associated with the resources of the biosphere reserve and its transition zone, with a view to ensuring their sustainable use and the improvement of the neighbouring populations' living conditions, within the framework of integrated regional development.” The interdisciplinary and multi-institutional research approach became necessary in order to provide better answers to one of the most essential questions for arid countries: how can the conservation of ecosystems and biological resources be reconciled with their sustainable use in the face of increasing poverty?

But what is the biodiversity situation in the Mare aux Hippopotames Biosphere Reserve and what are the lessons learnt in biodiversity management? On the basis of confronting the needs expressed by the users of research products and previous experiences, the research activities were defined for the zone.

These activities should develop social innovations and experiments with participative methods involving the populations in sustainable resource management.

In order to see these research activities through, a multidisciplinary and multi-institutional team was formed, regrouping national and regional research and training structures associated with the environment or its utilization, and various United Nations organisms including UNESCO.

3. Scientific knowledge for supporting conservation and the sustainable use of resources

Climate change has had numerous effects at various levels, with particular consequences for the ecosystems and biodiversity, which in turn influence the means of survival and well-being of the populations. These consequences are worsened by inappropriate natural resource management. The resulting environmental changes affect food production systems, contributing to malnutrition and famine. New health-related challenges are expected due to predictions of an increase in vector-borne diseases such as malaria. The prevailing image therefore often portrays an increased precariousness of the condition of plant and animal products. African populations are already living on the frontlines of the impact of climate change, and adapting over the course of time has been the survival alternative. In the face of nature's growing hostility, the populations have long been opting for traditional strategies for water and land conservation. For this reason, the results obtained are operational for accompanying the anticipatory answers to climate change at the level of the riparian populations, ecosystems and the biosphere reserve's biodiversity. This data summary puts emphasis on biodiversity.

3.1 Flora diversity

The survey of the gallery forests' flora indicates 270 species divided among 198 genera and 70 families. Of these 70 families, only 10 belong to the Monocotyledonae class, with 37 genera and 51 species, whereas 60 species are from the Dicotyledonae class where Leguminosae constitute the biggest group, comprising 3 families. In the gallery forests of the Hippopotamus Lake, the ratio of the number of genera to the number of species is 1, whereas it varies between 0.5 and 1 in other locations.

Analysis of the flora shows a high percentage (61.7%) of Guineo-Congolese formations, as compared to Sudano-Zambezian formations (38.3%), contrary to the findings of Sall *et al.* (1997), quoting Guinko (1984), in the surrounding savannah (2.1% of Guineo-Congolese types and 62.4% Sudano-Zambezian types).

According to Sall *et al.* (1997), quoting Adjanohoun, the predominance of Guineo-Congolese-Sudano-Zambezian formations (61.7%) is indicative of an increased similarity between coastal savannah and Guinean and Sudanese savannah formations. The high percentage of Guineo-Congolese formations indicates that the classified forest galleries of the Hippopotamus Lake and Guineo-Congolese forest formations have many floristic similarities. They constitute a relic of a former wooded formation.

In the more southern savannah galleries of Lamto, Sall *et al.* (1997), quoting Devineau, have reported a rate of 70% to 75% of Guineo-Congolese formations as compared to 15% Sudano-Zambezian formations.

Aquatic vegetation, one of the reserve's distinctive features, has particularly been documented. As far as the lake's aquatic vegetation is concerned, 106 taxa were recorded, of which 15% were hydrophytes, 44% helophytes, 20% accidental hydrophytes and 24% transgressive hydrophytes. This flora comprises 34 families of which 68.4% are dicotyledons, 18.4% monocotyledons and 10.5% pteridophytes and bryophytes.

Analysis of these elements and phytogeographical groups highlights the widely distributed plant category, revealing that 40.3% of the species encountered are from tropical Africa, 23.5% are pantropical, 12.2% are paleotropical and 5.6% are Afro-Asian and cosmopolitan species. In the regional chorology, the most abundant taxa are, in descending order, Guineo-Congolese and Sudano-Zambezi taxa at 64.1%, Sudano-Guinean taxa at 22.6%, Sudano-Zambezi taxa at 7.5% and Sudanese taxa at 4.7%.

These proportions are indicative of several facts.

They reveal that the water courses are ascent paths for Guinean flora in the Sudanese region. These various chorological characteristics emphasise the originality of this flora which adapted to very special environmental conditions.

The surveys on the anthropogenic impact show that different socio-professional groups have multiple and various interests in the reserve. As far as their resource needs are concerned, pastures are in fourth place, after medicinal plants, firewood and fish. In other respects, bush fires and excessive logging constitute the main causes of vegetation deterioration, while stock farming and agriculture are in third and fourth place, respectively.

3.2 Fauna diversity

The second biodiversity domain relates to fauna. The fauna of the Mare aux Hippopotames Biosphere Reserve is famous for its hippopotami (*Hippopotamus amphibius* Linné 1758) which permanently inhabit the area and have given it its name: Mare aux Hippopotames Biosphere Reserve (*Réserve de Biosphère de la Mare aux Hippopotames*). Other species such as fish, birds and mammals are also found there. The last two components of fauna diversity will only be examined briefly, as they are discussed in another article of this book.

3.2.1 Fish

With a surface area of 140 ha (which can reach 650 ha during the Mouhoun River's floods), this stretch of water is a natural depression situated in the heart of a 19 200 ha protected area, the largest in the national sub-basin of the upper Mouhoun. Thanks to the works of Blanc and Daget (1958) and Roman (1966), the fish of the Mouhoun Basin (e.g. Black Volta) are the best-known ichthyological fauna. The authors recorded approximately 52 species along the course of the Black Volta. With regard to the Hippopotamus Lake, knowledge of its piscicultural fauna can be attributed to the works of Corsi *et al.* (1988), Couteron *et al.* (1989), Baijot *et al.* (1994) and Sanon (1995). These authors recorded between 28 and 42 fish species. Among these fish, the four species *Citharinus citharus*, *Distichodus rostratus*, *Lates niloticus* and *Bagrus bayad* (Sanon 1995) were accidentally present in the lake, due to the flooding of the Mouhoun River. The fluctuation

of piscicultural diversity in the lake is influenced by factors related to climate (drought, floods), anthropogenic activities (fishing) and techniques used to record fauna.

The most recently collected data list 37 fish species divided among 31 genera and 20 families. The Cichlidae (6 species), Mormyridae (6) and Mochokidae (5) families had the most number of species. The genera with the most species were *Synodontis* (4 species), *Polypterus*, *Marcusenius* and *Hemichromis*, with 2 species each. Among the 37 species, the following seven were occasionally or rarely encountered in catches: *Auchenoglanis occidentalis*, *Bagrus bajad*, *Citharinus citharus*, *Distichodus rostratus*, *Lates niloticus*, *Parachanna obscura* and *Labeo* sp. Apart from these river species which are accidentally encountered in the lake, there were also ubiquitous species such as species belonging to the Clariidae family (especially *Clarias* sp.) which were found in both ecosystem types (lotic and lentic).

Captured fish species were identified using the systematic description of Lévêque *et al.* (1990, 1992). Ichthyological diversity was analysed using the generic coefficient (number of species over the number of genera) and the family spectrum defined by Malan *et al.* (2007). The generic coefficient was 1.16, and the proportion of families and monospecific genera were 70% and 87%, respectively. The low value of the generic coefficient and the predominance of families and monospecific genera are indicative of the Hippopotamus Lake's rich ichthyological diversity, which is closely linked to the fertility of the lake's waters and the extent of the Mouhoun River's floods.

The main species of commercial interest which are fished come from five fish families, namely and in descending order, the Cichlidae (55%) mainly including the three species *Oreochromis niloticus*, *Sarotherodon galilaeus* and *Tilapia zillii*, the Osteoglossidae (20%), with only the *Heterotis niloticus* species, the Clariidae (9%), with the *Clarias* genus, the Gymnarchidae (6%), with only the *Gymnarchus niloticus* species, and the Mochokidae (3%), with various species of the *Synodontis* genus. Various other species used for alimentary or economic purposes were found in 7% of catches, that is to say they were occasionally caught. Examples of these species are *Lates niloticus*, *Auchenoglanis occidentalis*, *Parachanna obscura*, and *Labeo* sp.

Species which are often fished are *Oreochromis niloticus*, *Sarotherodon galilaeus*, *Tilapia zillii*, *Heterotis niloticus*, *Gymnarchus niloticus* and *Clarias angularis*. Calculations of the utilization rates also show that *Tilapia* (*Oreochromis niloticus*, *Sarotherodon galilaeus*) are being overfished, whereas other species such as *Heterotis niloticus* are abundant in the aquatic systems.

It has thus been established that the main species of economic interest present higher growth than those reported by later studies focusing on the same species and other fisheries in the south-western region of Burkina Faso.

The inhabitants of the reserve's riparian villages have organised themselves in order to make the most out of the fishing activities in the lake and the reserve's rivers. Throughout the year, the majority of young villagers go there to obtain the necessary amount of fish for their household consumption, whereas a smaller group (less than eight young individuals) practises small-scale fishing for commercial purposes.

3.2.2 Birds

The Hippopotamus Lake of the Mare aux Hippopotames Biosphere Reserve is a Ramsar site, which harbours a considerable number of the country's avifauna. Poussy and Bationo (1991) recorded 125 bird species divided among 41 families of which the majority are the Accipitridae, with 15 species, followed by the Ardeidae and Ploceidae, with 8 species each, the Estrildidae and Columbidae, with 7 species each, the Alcedinidae, Charadiidae, and Sylviidae, with 6 species each. The bird species of the Sudano-Guinean savannahs which have been recorded at the site include *Poicephalus senegalensis* (Senegal Parrot), *Musophaga violacea* (Violet Turaco), *Merops bullocki* (Red-throated Bee-eater), *Coracias cyanogaster* (Blue-bellied Roller), *Lybius dubius* (Bearded Barbet), *Hirundo leucosoma* (Pied-winged Swallow), *Cossypha albicapilla* (White-crowned Robin-Chat), *Eremomela pulsatilla*, *Turdoides reinwardii* (Blackcap Babbler), *Anthoscopus parvulus* (Yellow Penduline Tit), *Nectarinia coccinigaster* (Splendid Sunbird), *Lanius gubernator* (Emin's Shrike), *Corvinella corvine* (Yellow-billed Shrike), *Ptilostemon afer* (Ivory Thistle), *Lamprotornis purpureus* (Purple Glossy-Starling), *Petronia dentata* (Bush Petronia), *Plocepasser superciliosus* (Chestnut-crowned Sparrow-Weaver), *Pytilia phoenicoptera* (Red-winged Pytilia), *Lagonosticta rara* (Black-bellied Firefinch), *Estrilda troglodytes* (Black-rumped Waxbill), and *Emberiza affinis* (Brown-rumped Bunting), among others. All these species are believed to nest in the area.

3.2.3 Wild mammals

The surveys conducted in the biosphere reserve and among the riparian village populations show that there are 35 species of wild mammals in the Mare aux Hippopotames Biosphere Reserve, of which 28 are known by more than 50% of the population. Field trips and pedestrian surveys made it possible to confirm the presence of 28 species of the fauna which are well-known among the population. These species were identified through direct observation and evidence indicating their presence (faeces, tracks, burrows and the animals' impact on vegetation) in the different surveys. The most significant of these mammals were roan antelope, bushbuck, warthog, elephant, duiker and oribi, whose presence was most often confirmed through evidence of their presence. Today, the numbers of some of these species are decreasing drastically, particularly kob (*Kobus kob*), waterbuck, bohor reedbuck and hartebeest. Setting up corridors for large wildlife between the different classified domains of the region, namely the Maro classified forest and the Tere classified forest, could make their habitats more secure and viable.

4. *The issues related to biodiversity in the biosphere reserve: the need for a shared view of resource management*

The Sahalian and land-locked country of Burkina Faso is essentially agricultural, as this activity represents 35% of the GDP and is practised by 85% of the working population. Burkina Faso is classed among the world's poorest countries, and 45.3% of its population

lives below the poverty line (INSD 2000). The majority of the population is dependent on natural resources. This situation leads to the deterioration of natural resources and a general loss of biodiversity. The climate is of a dry tropical type, with two distinct seasons: a rainy season and a dry season. Annual rainfall varies between 350 mm in the country's extreme north and 1 200 mm in the southern part. For many years, a deterioration of climatic conditions has been observed. Bonkougou (1985), quoting Toutain & Wispelaere, notes that "the rainfall averages between 1971 and 1976 are significantly lower than those of previous decades", and that the limits of certain isohyets have moved further south by some 50 km. Similarly, Albergel *et al.* (1984) and Bonkougou (1985) have shown that since 1920, there has been a southward latitudinal movement in the decennial rainfall averages. For example, the 500 mm isohyet which was clearly situated in the north at 15°N outside of Burkina Faso during 1950/60 has moved over the years.

While the climatic conditions are definitely one of the causes of deterioration, the phenomenon of poverty which affects 45.3% of Burkina Faso's population contributes greatly to it (INSD 2000). In fact, the combined effects of the deterioration of climatic conditions and inappropriate land management (intensive agriculture, overgrazing, bush fires, etc.) have led to and continue to lead to serious desertification problems which occur when the utilization of biological and natural resources affect the ecological and biological foundations of their renewal. However, while the pressures affecting natural resources used to be localised, they currently threaten their entire ecological balance, particularly in the biosphere reserve's region which is a zone favoured for internal migrations. In order to develop a shared view of the answers to these problems, it is necessary to take into account all the different local, regional and national issues.

4.1 *Local and national issues*

The riparian populations, which are grouped into the Bala, Tierako, Sokourani and Bossora villages, are situated on the edge of the forest and comprise the Bobo farmers, the Mossi migrants and the Fula stock farmers. Various forms of interaction exist between the riparian populations and the forest (Poda 1986).

1. The forest and the lake are considered to be forms of divinity by the surrounding villages and are used as places of sacrifice: a large number of rites and customs (fetishes and various ceremonies) are based on the forest for the Bala, Sokourani, Tierako and Bossora villages and on the lake for the Bala and Sokourani villages.
2. The forest is an additional source of food, and exercising one's right of user (collecting fruit, mushrooms, leaves for sauces, medicinal plants, and fishing) provides many essential elements for the populations' day-to-day life.
3. The inhabitants, mostly farmers, benefit from the reserve's micro-climate which positively affects rainwater cultivation.
4. Young generations who did not experience the classification of the forest learn about it through word of mouth; the elders show them the boundaries and boundary markers of the forest and also teach them their rights and responsibilities associated with the forest and the lake. This attitude has allowed them to develop a sense of collective responsibility among the populations for the protection of the forest.

5. The migrants know that the forest is classified; the fields that were attributed to them are situated outside of the forest. However, they do not have the same practices as the indigenous populations. Along the forest's boundaries, there are several migrants' agricultural hamlets which progressively form permanent villages, and the stock farmers settle there permanently, extending the agricultural and grazing areas.
6. Small-scale and customary fishing is practised at the lake alongside the group of professional fishermen from surrounding villages and is supervised by the commissioner; these activities constitute a significant economic pole in the region.
7. As far as infrastructure is concerned, the biosphere reserve contributes to the improvement of the riparian populations' living conditions (agroforestry, community radio, the craft industry, income-generating activities).
8. The region's administrative and political authorities have a strong attachment to the forest and the lake; all role players wish for the biosphere reserve to become reality and for the protective attitude towards natural resources to be maintained in order to support development during an era where an aggressive climate and human pressures on the environment are intensifying.

This shows that cooperation at the local level is more and more necessary for effective resource management.

In order to reverse the environmental deterioration trends, a concerted view of the biosphere reserve (MAB/UNESCO) and of the land management programmes (PNGT) and conservation programmes (OFINAP) can be considered as an approach for preserving the region's natural resources while participating in its development (Bonkougou & Poda 1987). The combined management of forests and land is necessary for the following reasons:

- (a) Natural resource management is a challenge insofar as these resources suffer great anthropogenic and climatic pressures.
- (b) The remaining forest and fauna constitute a precious biodiversity heritage, but are also greatly threatened.
- (c) The growing demand for firewood in Bobo-Dioulasso, the country's second-largest city, exerts an increasingly strong pressure on the neighbouring natural forests, including the forest in the Mare aux Hippopotames Biosphere Reserve situated at 60 km from Bobo-Dioulasso.
- (d) The land management activities which were launched in certain villages provided thoroughly encouraging results which are worth developing in the biosphere reserve's region.
- (e) The biosphere reserve management plan constitutes a precious asset and tool for making a success of combined management.

The Mare aux Hippopotames Biosphere Reserve constitutes an excellent way of integrating conservation and development by putting the local populations' participation and scientific knowledge to good use. From this point of view, the MAB programme's biosphere reserve concept increases the chances of the regional development programme being successful in land management.

4.2 *The necessity for a concerted view of the future*

Given the local and national issues, it appears that within the context of Burkina Faso as well as the entire Sahel region, poverty constitutes the main element leading to the deterioration of biosphere reserves. The UNDP's report (1998) states that "the poor are forced to use natural resources in order to survive, and this environmental deterioration only increases their poverty, which prevents them from investing in the environment's restoration". In order to escape from the vicious circle described in their report, would it not be necessary to make significant changes in the world-wide appreciation of natural resources, especially biological ones, by increasing international solidarity towards the riparian populations living in biosphere reserves who are currently the main guardians of biological natural resources?

Today, environmental problems, whether they are global (climate change), thematic (loss of biodiversity) or local (deterioration of soils and poverty), are recognized as problems which concern everyone (Horeau 1999). The future of development and the sustainable use of natural resources is conflictual within the populations (farmers, stock farmers and fishermen), between the populations on a global scale and the local and international authorities through regulatory laws and conventions, and it is also complementary between these same role players. For this reason, the riparian populations of the Mare aux Hippopotames Biosphere Reserve as well as those living in other poor countries' nature reserves will most definitely not say "yes" to and applaud national, regional and international strategies for development and the sustainable use of natural resources which exclude their participation, while they await their own demise. The populations are more and more aware of the rights they need to conquer with the benefit of living with natural resources.

5. *Conclusion*

Much like all the other countries of the Sahel, Burkina Faso is stricken by drought and the deterioration of its natural resources. This situation leads to migrations from the damaged northern areas towards the better southern areas. It is in this latter region, which is particularly favourable for agriculture, where Burkina Faso is experimenting with the concept of UNESCO's MAB programme, with the classified forest of the Hippopotamus Lake having been declared a biosphere reserve in 1987. The development-related research activities conducted in this area aim to reverse the process of biological resource deterioration which affects the quality of life of riparian communities.

Land management plans in Burkina Faso are implemented with the active participation of the local populations. By rigorously taking into account the zonation of the Mare aux Hippopotames Biosphere Reserve, the implementation of the global approach described as the "terroir approach", increases the chances that the Seville Strategy for biosphere reserves will be successful. From this viewpoint, the Mare aux Hippopotames Biosphere Reserve could reconcile biodiversity and natural resource conservation and their sustainable use to the benefit of local development.

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7



Developing a Management Plan for the Waterberg Biosphere Reserve, South Africa: Challenges and Opportunities

Enjeux et opportunités dans l'élaboration d'un plan de gestion pour la réserve de biosphère de Waterberg, Afrique du Sud

RUPERT BABER • KELLY ABRAM¹

Abstract

The Waterberg Mountain Complex, home to the Waterberg Biosphere Reserve (WBR), is located in the Limpopo Province of South Africa. The WBR was designated by UNESCO in accordance with the MAB (Man and the Biosphere) Programme in 2001.

The WBR is topographically complex, comprises six different vegetation types and has a very high biodiversity with low population numbers. During the last two decades the WBR has experienced a marked conversion in land use from traditional agricultural practices to game farming and ecotourism. Although the WBR is delineated into core, buffer and transition areas, the need has arisen for a new arrangement due to various challenges facing the WBR. Subsequently a biosphere reserve management plan was completed in 2011 that reflects an expansion of the biosphere reserve from the current 654 000 ha to over 1 750 000 ha. The management plan has been adopted by the relevant local authority and is used to guide future development within the biosphere reserve. The WBR will use UNESCO's 10 year review process to apply for the expansion of the WBR area towards a well-functioning biosphere reserve that will address protection of the environment as well as various socio-economic challenges.

This paper addresses the context of the need for land use and management planning in the case of the WBR, the process followed, the outcomes achieved and the projects identified to address the challenges and opportunities of the future.

Key words: Waterberg; biosphere reserve; management plan; ecotourism; land use; governance

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Résumé

Le complexe montagneux de Waterberg, berceau de la Réserve de biosphère de Waterberg (WBR) est situé dans la province du Limpopo en Afrique du Sud. La WBR a été classé par l'UNESCO en 2001 en vertu du programme MAB (Homme et Biosphère).

La WBR se caractérise par une topographie complexe, comprenant six types de végétation différente avec une biodiversité élevée et une densité de population faible. Au cours des deux dernières décennies, la WBR a été soumise à une conversion remarquable par rapport à l'utilisation de la terre, passant de pratiques agricoles traditionnelles à l'élevage de gibier et l'écotourisme. Bien que la WBR soit délimitée en zones principales, tampons et de transition, une nouvelle structure s'est avérée indispensable en raison des divers enjeux la confrontant. En résultat, un plan de gestion de la réserve de biosphère a été achevé en 2011, reflétant une expansion de la réserve de biosphère de la superficie de 654,000 ha actuelle à une superficie dépassant les 1750,000 ha. Le plan de gestion a été adopté par l'autorité locale responsable et est utilisé pour orienter le développement futur au sein de la réserve de biosphère. La WBR utilisera le processus de révision sur 10 ans de l'UNESCO pour faire une demande d'expansion de la zone de la WBR en faveur d'une réserve de biosphère entièrement opérationnelle qui englobera la protection de l'environnement et les divers enjeux socio-économiques.

Ce document traite du contexte relatif au besoin d'aménagement du territoire et à la planification de la gestion dans le cas de la réserve de biosphère de Waterberg, du processus suivi, des résultats obtenus et des projets identifiés pour aborder les enjeux et les opportunités de l'avenir.

Mots-clés: Waterberg; réserve de biosphère; plan de gestion; écotourisme; utilisation de la terre; gouvernance

1. Introduction

Biosphere reserves do not have any legal status under South African law. In the ensuing years following the establishment of the Waterberg Biosphere Reserve, it was recognised that in order for the existence of the Reserve to have any impact on land use practices on the ground — a necessary condition to fulfil its conservation and sustainable development mandate — a process was necessary not only of improved strategic planning, but also of engaging with the various levels of government who had legal authority over land use issues. The development of a management plan for the Waterberg Biosphere Reserve had to be a collaborative effort between government and the Reserve, and needed to address issues of spatial planning, development guidelines and the long-term conservation objectives. In addition, the original demarcation of the Reserve, when established in 2001, was limited in both scope and design. Hence the management plan had to lay the groundwork for an application to UNESCO to enlarge the Reserve to encompass the entire Waterberg Mountain Complex. Finally, the Waterberg Biosphere Reserve, as

in the case with all biosphere reserves, has its own unique set of socio-economic and governance challenges, and these too needed to be addressed by the management plan.

This paper addresses the context of the need for land use and management planning in the case of the Waterberg Biosphere Reserve, the process followed, the outcomes achieved and the projects identified to address the challenges and opportunities of the future. First, however, it is necessary to provide a background to this important conservation area in South Africa and to the evolution of the Waterberg Biosphere Reserve itself.

2. Description of the Waterberg Mountain Complex

The Waterberg Mountain Complex (WMC), home to the Waterberg Biosphere Reserve, is located in the western section of Limpopo Province of South Africa, approximately 150 km north of Pretoria. It falls within the Savannah biome and lies not far below the tropic of Capricorn, and the border with Botswana. Figure 1 shows the extent of the WMC, the existing Waterberg Biosphere Reserve (WBR) (654 033 ha), and the planned expanded Waterberg Biosphere Reserve (Exp-WBR) (1 727 614 ha).

The topography of the WMC is fairly complex with a series of great curved and folded sandstone buttresses, inselbergs, deep ravines, sandy plateaus and gently sloped hills. The complexity of the topography allows for a rich diversity of micro habitats and

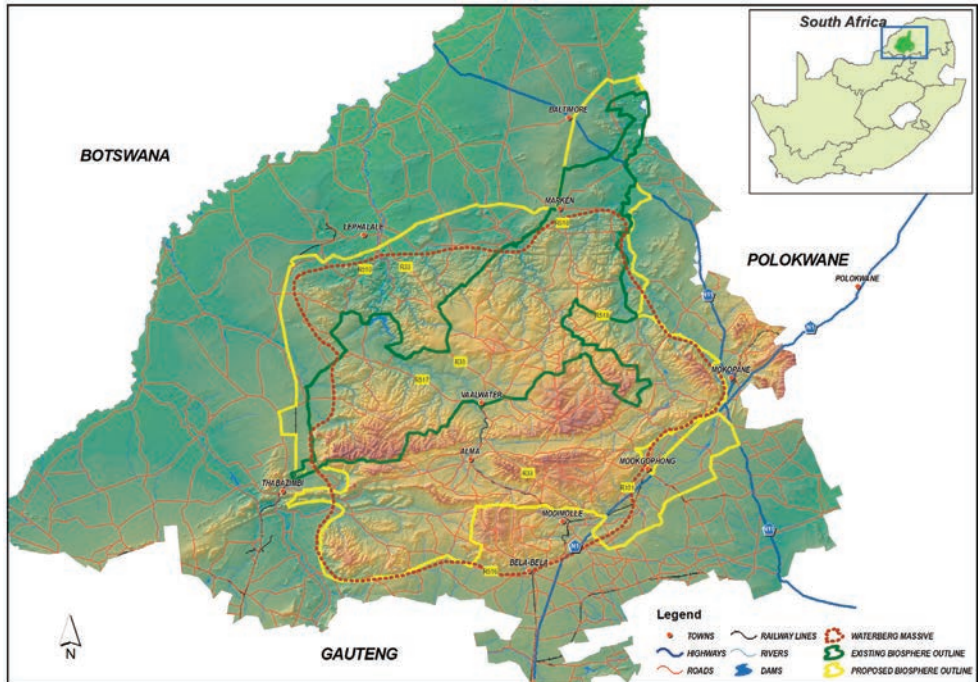


Figure 1: Waterberg District indicating Waterberg Mountain Complex (WMC), existing Waterberg Biosphere Reserve (WBR) and proposed expanded Waterberg Biosphere Reserve (Exp-WBR)

supports much biodiversity. The influence of water has also been a major contributor to the topographical features of the area, with not only the original geology of the area but with later day erosive features such as incised river valleys and rocky gorges. Due to the sandstone dominant rocks, soils in the WMC are leached sandy soils of poor quality (Walker & Botha 2005). The WMC has a temperate climate and is classified as semi-arid to arid with annual precipitation ranging from 350 to 900 mm (Environomics 2010). Temperatures can range from -5°C to 38°C .

Water is an important feature of the WMC and the whole biosphere reserve represents a major and critical water catchment for the province of Limpopo as well as being an important source for the Limpopo River (Walker & Botha 2005). Much of the water is not restricted by dams and, as a consequence, supports a much larger area than the WMC.

The WMC comprises of six different veld types, two of which are classified as endangered (Environomics 2010). Within these veld types there are many more micro habitats all of which contribute to the high biodiversity value of the WBR.

Biodiversity of both flora and fauna is high along with population numbers of many species. (The following data is taken from Walker and Botha, 2005). Plant species diversity has been recorded at: grasses 248 species; sedges 83 species; aloe 25 species; other monocotyledons 197 species; trees 504 species; other dicotyledons 906 species; cycads 1 species; ferns 34 species; mosses 59 species and liverworts 35 species. Invertebrates will number in their thousands, a couple of examples include; lacewings 24 species; butterflies and moths 185 species; and scorpions 10 species. Vertebrate species includes: bony fish 44 species; amphibians 19 species; reptiles 83 species; birds 381 species; and mammals 119 species.

To indicate the representativeness of the area for mammals and birds (which can be seen as indicators of habitat health), the WMC holds 49% of South African mammals and 50% of South African birds in 1.2% of the country. The area contains at least 18 threatened or scarce species of plants, 11 threatened species of birds, 4 threatened species of reptiles, 4 threatened species of fish, one threatened species of butterfly, and 18 threatened species of mammals (Environomics 2010). All of these are deemed of the utmost importance for biodiversity conservation.

Given its relatively close proximity to Gauteng, South Africa's economic hub, the WMC has a remarkably low population density. Although there are a number of rural towns just off the periphery of the WMC, and 30 rural settlements off the north eastern escarpment, there is only one town and one hamlet on the plateau itself. Furthermore, agriculture is not a prominent land use. This is a function of the area's historical inaccessibility and poor soils, and the fact that there are no mineral deposits worth mining within the WMC. The Waterberg sandstone rocks were laid down by a very long-lived river system that drained from a mountainous region to the north-east, more or less where the town Tzaneen is today, during the period 1900–2500 million years ago. In the course of their long journey, the sediments carried by these rivers became clean, well-sorted and almost entirely winnowed or leached of any useful minerals that they might have contained when they started their journey. The Waterberg sediments were

formed at a time when the only life on earth consisted of single-celled, carbon-monoxide/dioxide respiring organisms: there were no plants, and no animals — and so there are also no fossils present from which to have formed fossil fuels like coal, oil or gas (Wadley 2012).

Apart from its low population density, the character of WMC is a function of changing land use patterns. During the last two decades a number of countries in southern Africa have experienced a vast expansion in the number of properties that have converted from conventional agriculture (livestock and crop farming) to game farming. The most important factors driving private conservation development are well-defined property rights over land and wildlife resources and the elimination of government subsidies favouring livestock production in the commercial farming sector (Krug 2001). This conversion trend has been particularly strong within the WMC, which is considered by some to be the very heart of the game farming industry in South Africa. Thus, while approximately 75% of land in the existing WBR (90% in Exp-WBR) is in private hands with freehold title, up to 80% of this land is utilized as game farms or private game reserves (Figure 2). In addition, 15% of WBR constitutes community or provincial game reserves or national parks (Aurecon 2010). Linked to this conversion process has been a remarkable reintroduction of game species to the area. The San rock art in the Waterberg portrays a rich biological diversity of mammals such as red hartebeest, eland, elephant, rhinoceros, kudu and giraffe. Sadly from the 1850s the vast wildlife resources of the Waterberg were decimated by European hunters, to the point where very few

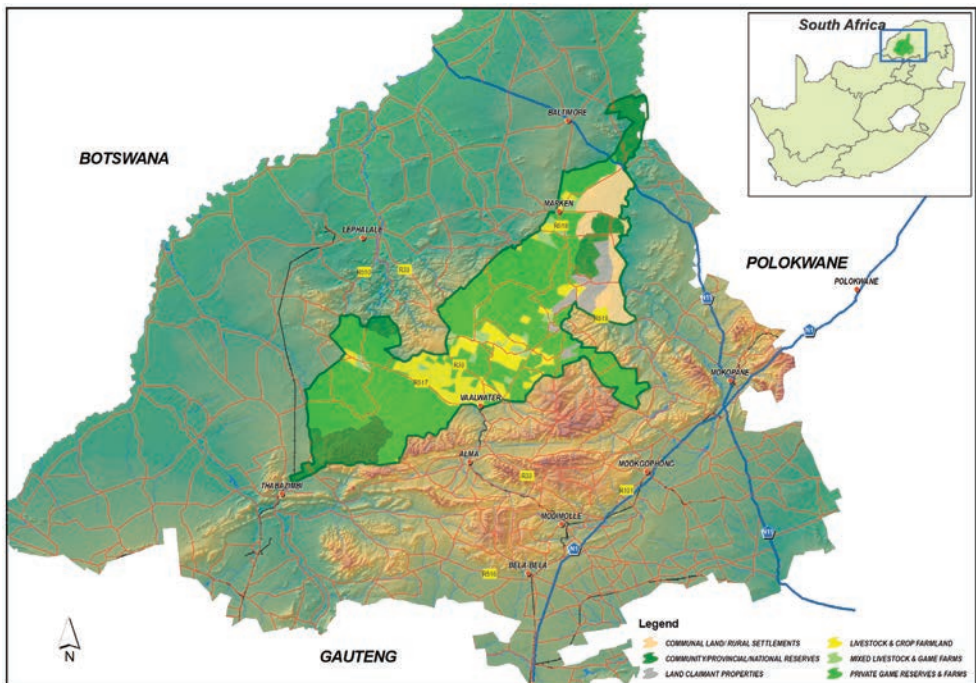


Figure 2: Land use patterns in WBR in 2010

species remained by the turn of the 20th Century. However today practically all species known to have occurred in the WMC have been successfully reintroduced.

The overall result is a rich wildlife area with a certain wilderness quality devoid of human development, exemplified by large properties such as Lapalala Wilderness but present to some degree throughout the area. A sense of place characterised by wide and pure visual landscapes is a key driver in attracting nature based tourists to the area, probably just as important as the increasing wildlife concentrations and biodiversity that have followed the development of the wildlife industry in the area.

3. Challenges facing the Waterberg Biosphere Reserve

When the Waterberg Biosphere Reserve concept was being developed during 1997 to 1999, the layout (boundaries and zones) were set out through coordination between participating government departments, private landowners and rural communities that were engaged by the steering committee. An important organisation in the creation of the WBR was the Waterberg Nature Conservancy (WNC). This organisation had members that were landowners who were orientated to conservation practices. As a consequence the WBR was produced around these participating members, where state land with formal conservation status became the core areas, and private land belonging to members of WNC became buffer areas. Little regard was given to important habitats or ecosystems, river catchment areas nor biodiversity hotspots in the development of the original WBR. Figure 3 illustrates the existing zonation scheme of WBR.

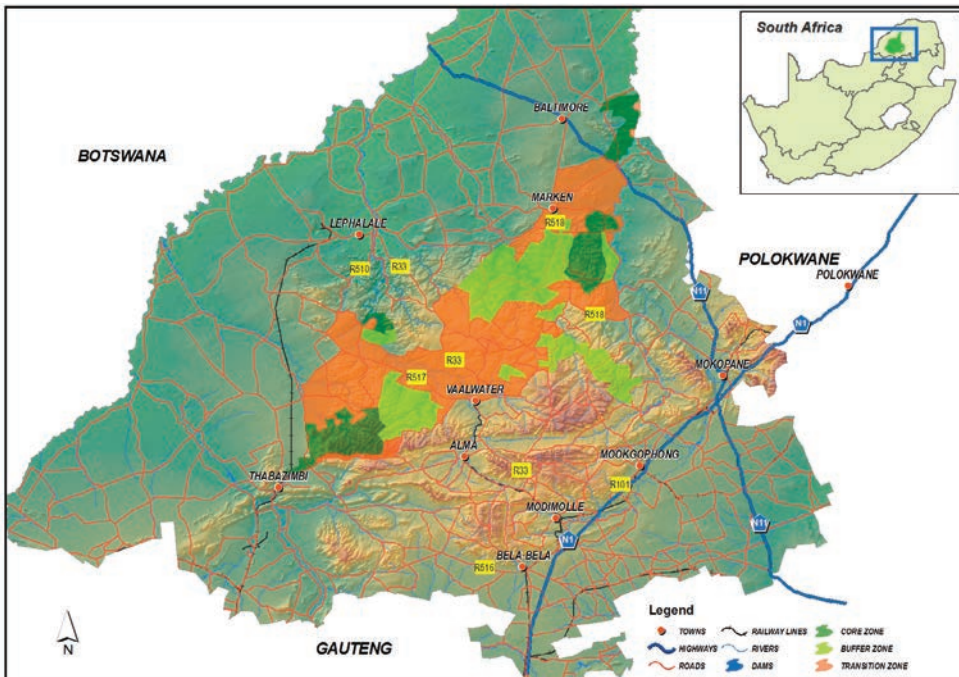


Figure 3: Core, buffer and transition zones in WBR

While an inadequate and unscientific existing spatial plan is sufficient rationale for the expansion and change of spatial arrangement of the zones of the WBR, a number of factors have further strengthened the need for a new arrangement. These are as follows:

- **Development of the Waterberg Coal Field.** In the area between Lephalale town (just off the north western edge of Exp-WBR) and the Limpopo River, lies South Africa's richest remaining coalfield, from which Eskom, the national provider, hopes enough coal can be extracted to fuel the country's electricity demand for the rest of this century. Already home to one of the world's biggest collieries (Grooteegeluk) and one of the largest power stations (Matimba), with an even larger station (Medupi) now under construction, the Waterberg coalfield is expected, within the next decade, to support a *quadrupling* of its current electricity output, as well as the country's first coal liquefaction plant. The westward extension of the field into Botswana is also under intensive evaluation for coal and methane gas mining. Although the coalfield falls outside the WMC, these developments potentially have several environmental consequences, including the intrusion into the wilderness of the associated transmission lines and water pipelines as well as the increased need for water extraction to serve the development. It is also expected that greater pressure will be put onto the WMC to deliver water to not only the booming town of Lephalale but also many of these associated developments through a process known as the Mokolo Crocodile Water Augmentation Project. Water issues are therefore seen as a critical current and future issue, with the WMC required to provide essential ecological services critical to the development of the entire South African economy.
- **Unemployment and weak linkages with the local economy.** In considering the widespread conversion to game farming, factors other than returns on capital or net operating income must be taken into account. A by-product of economic growth, certainly as experienced by the economic elite, is a set of factors — rising incomes, more education, more available leisure time, improvements in transportation and economic development generally — that all tend to accelerate the demand to use natural areas for recreation purposes (Tisdell & Wilson 2003, Porter *et al.* 2003). This “non-economic” motivation for entering game farming weakens the linkages between these properties and the local economy or local livelihoods. Many property owners in the WMC express their love of nature, appreciation of wildlife and desire for space and privacy as powerful motivating factors in their investment decisions. A common factor is that these owners are wealthy individuals who do not need to make a living from their wildlife properties. They are in a position to sustain ongoing operational losses in the knowledge that their land values will escalate as a function of its scarcity value rather than its productive output. This generally implies a low level of economic activity on these properties, with negative implications not only for labour intensity but also for backward and forward linkages with the local economy. A survey of WNC members indicated that approximately 40% of properties covering 16% of the total game farming component were for private use only, and while the remaining properties had some form of ecotourism, game breeding or

hunting operation, these were often low key operations more likely to offset a proportion of running costs rather than provide a net operating return on investment. This finding is consistent with the limited available evidence that suggests that the majority of game farms suffer from extremely low levels of profitability (Porter *et al.* 2003, ABSA 2003, Langholz & Kerley 2006). Labour input for eco-tourism properties was considerably higher than for private use only and hunting properties (8.2 per 1000 ha as opposed to 3.4 and 3.8 per 1000 ha respectively) (Aurecon 2010).

Closely related to this trend is the increasing demand for second homes and retired homes in the area, where the emphasis is on securing a residential opportunity rather than a game property *per se*. As urban areas have become increasingly perceived as dangerous and unstable locations, areas such as the WMC have become more desirable for both permanent and semi-permanent residence. In addition, views among international people about more permanent settlement in South Africa have changed dramatically since the ending of apartheid and the WMC is viewed as one of the safest parts of the country and blessed by a mild climate. Such leisure properties range from the super wealthy investing in exclusive stands in “big five” reserves, such as Welgevonden, which are visited only several times in a year, all the way to investors seeking to minimise their financial commitment by purchasing a freehold plot within a dense residential development where the number of owners sharing the fixed costs of the property is large relative to its overall size — a model known alternatively as “rural residential”, “eco-estates”, “bush estates” or “wilderness estates”. As is the case for leisure game properties, consumption led, migration-associated second home development often does not offer a sufficient range, or permanency, of employment opportunities to meet the needs of the host community (see Visser 2004).

Given the delinking of many wildlife properties from active production, and in the absence of local mining, industry or a strong agricultural sector — conventional agriculture is restricted to just 16.5% of WBR — it is not surprising that levels of unemployment in the WBR’s one town are exceptionally high, even by South African standards. For instance, a survey in 2010 of 2008 school leavers found that only 2% were in formal employment, and 75% were neither in further education, work experience volunteering, business or employment (author’s own survey). These results are consistent with an earlier detailed household survey in the same community (Jeffes & Mokoena 2003) which indicated an unemployment rate of 64% of women and 52% of men above 16 years of age. This form of extreme unemployment provides a significant challenge to sustainable development within the biosphere reserve, and implies that measures which facilitate ecotourism, with its high labour absorption rates, are a necessary function of the Reserve.

- **Fragmentation and densification of the landscape.** The drivers behind the increasing number of leisure properties also result in increasing fragmentation and densification of the landscape. This has a deleterious impact not only upon the area’s wilderness quality and sense of place, but also upon the ecological integrity of the area. Unsurprisingly, the greater intensity of densification is experienced in those

areas of WMC closer to the urban centres of Gauteng and the main arterial routes leading from them (Aurecon 2010).

- **Land reform.** Since 1998 over 120 000 ha of land within WMC have been gazetted as under claim under South Africa's Land Restitution Process, and approximately 21% of this land has already been transferred. It is unclear what proportion of the remaining area will be transferred in the future as landowners are in the process of challenging the validity of many of the claims in court. Nevertheless, the issue of land reform remains an important challenge to the vision of sustainable development in Exp-WBR. Despite a clear appreciation of nature and the WBR's conservation status, land claimant Community Property Associations (CPAs) face numerous challenges in benefiting from their newfound ownership of properties within WMC. These include limited knowledge of the wildlife and ecotourism industries, lack of post settlement support from government, group dynamics, lack of marketing networks and an inability to sell some of their land and thereby benefit from its scarcity value as opposed to its limited productive potential.
- **Rhino poaching.** Since 2008, rhino poaching has become a critical challenge to the ecotourism industry in WMC. Since the early 1980s the Waterberg had become a stronghold of white rhino (*Ceratotherium simum*) conservation and in 1990 became the first area in South Africa to implement black rhino (*Diceros bicornis*) conservation on private land (Walker & Walker 2012). Rhino are iconic species and one of the "big five". As such, their presence is a key to attracting overseas tourists to the area, particularly to smaller private reserves unable to host elephants or lions. Their potential demise threatens the WMC's future as a significant nature-based tourism destination with improved support for local employment.

Collectively these challenges underpin the need for a comprehensive management plan for the Waterberg Biosphere Reserve that would accomplish the following:

- A review of the boundaries of the Reserve, including the extent to which the Reserve could be expanded to encompass the entire WMC;
- Rezoning along environmentally and socio-economically sound criteria;
- Establishment of unambiguous development guidelines for each zone expressed in town planners terminology in order to promote appropriate development while conserving as far as possible the Reserve's visual landscapes and resultant comparative advantage as a nature based tourism destination;
- Given this structural architecture, identify projects that address specific challenges or opportunities facing the WBR.

4. **Process followed in developing the management plan**

The WBR management plan was completed in 2011. It has provided the basis for an application to UNESCO to expand the Waterberg Biosphere Reserve from the current 654 000 ha to over 1 750 000 ha, encompassing the vast majority of WMC as well as the adjacent RAMSAR site, Nylsvley and the provincial nature reserve, Wonderkop.

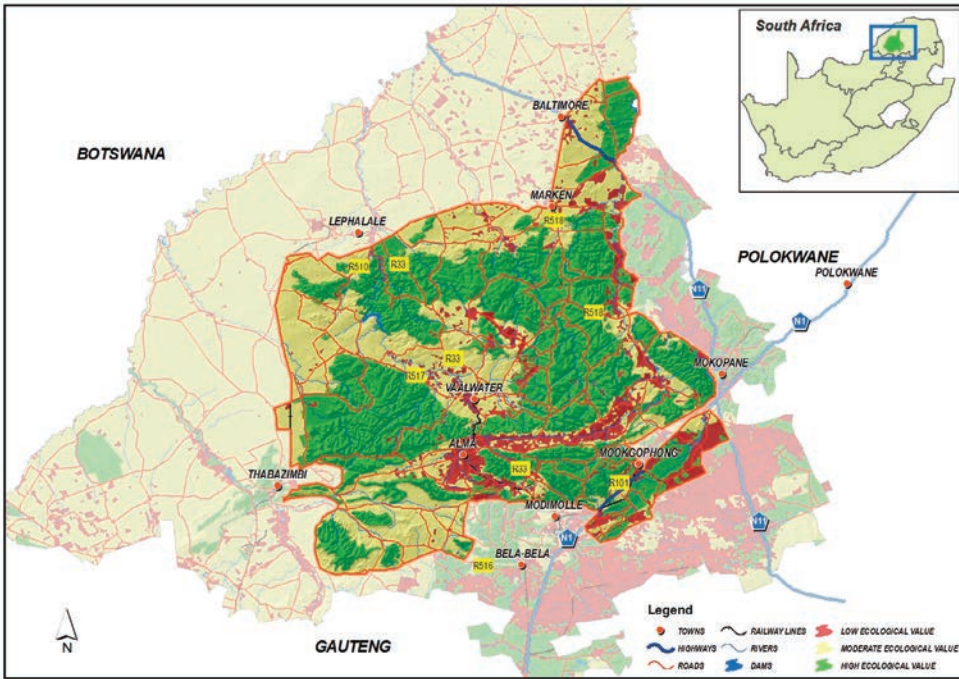


Figure 4: Status of Ecology in Exp-WBR

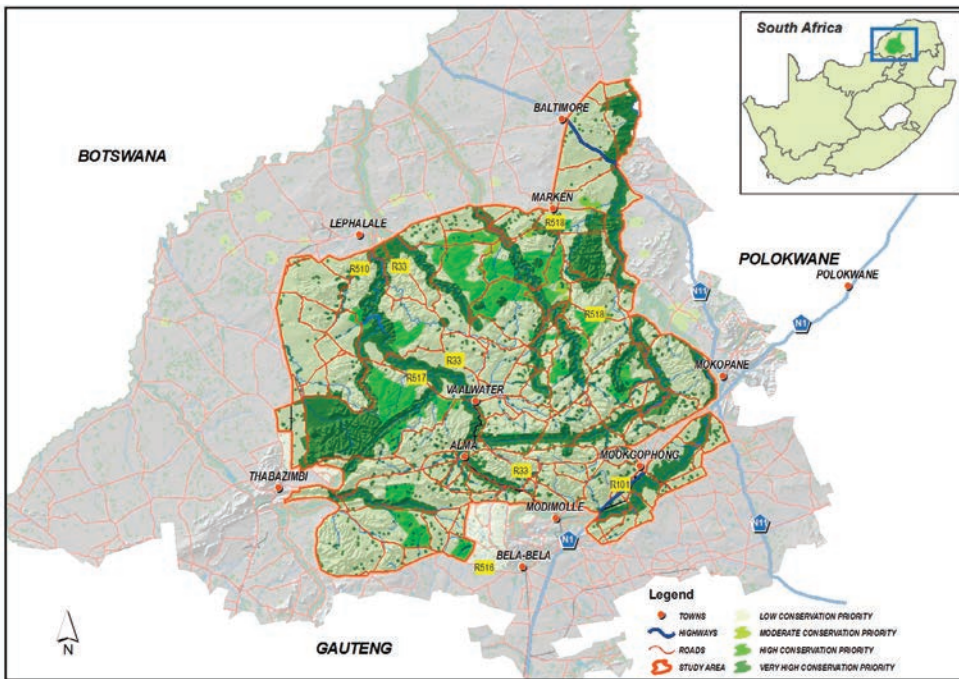


Figure 5: Areas of conservation priority in Exp-WBR

The zonation of Exp-WBR was based upon the evaluation of three criteria: the status of the ecology; conservation priorities; and existing development pressure. The methodology used was to weight and overlap these effects to provide a composite spatial plan going forward (Contour & Associates 2011).

- **Status of the ecology.** The status of the ecology formed an important consideration as the least disturbed or transformed areas are valuable conservation assets, whilst the highly disturbed and transformed areas are unlikely to be of great conservation value (Figure 4). It is important to note that many of the most sensitive areas in WMC have already been disturbed to the point of no return. These occur mainly in the valley bottoms on historic wetlands on productive soils that have been utilised for cultivation and related human settlement.
- **Conservation priorities.** Another very important layer comprises the conservation priority areas of the WBR—consisting of existing formally protected areas, wetlands, river systems, archaeological sites, heritage sites and sites of endemism (Figure 5). It is the aim of the WBR to include as much of these areas into the Core Area, or at least the Buffer Zone, with the aim to give these areas the best possible protection.
- **Development pressures.** WMC has historically been under development pressure from mainly intensive agriculture and, to a very limited extent, human settlement. These development pressures have, until recently, been mostly on the flat valley bottoms with good soils and on more accessible areas on the periphery. As discussed above, a more recent phenomenon has been the proliferation of dense residential developments which now also target the more pristine and mountainous parts, thereby threatening their natural character (Figure 6). It is the aim to have most of these areas managed inside the Transition Zone and to proactively channel any future proposed developments of this nature into this zone through the use of stringent development guidelines in the buffer and core zones. In this way the transition zone would become the focus for economic and social development within the Exp-WBR, rather than the current trend of haphazard development potentially impacting upon the entire Reserve.

The result fed into a spatial planning process that was at the same time being conducted for the Waterberg District as a whole, namely the Environmental Management Plan (EMF) (Figure 7—Environomics 2010). This plan went through a full public participation process and has been adopted at national level. The fact that the biosphere reserve was conducting a planning exercise at the same time enabled it to have a direct and incisive impact on the final outcome. The distinctions between the two plans are twofold.

Whereas the EMF demarcated the WMC into essentially three zones:

- **EMF1**—Conservation for research and protection focus (with limited tourism);
- **EMF2**—Tourism focus within a conservation setting;
- **EMF9**—Agriculture focus with a tourism component;

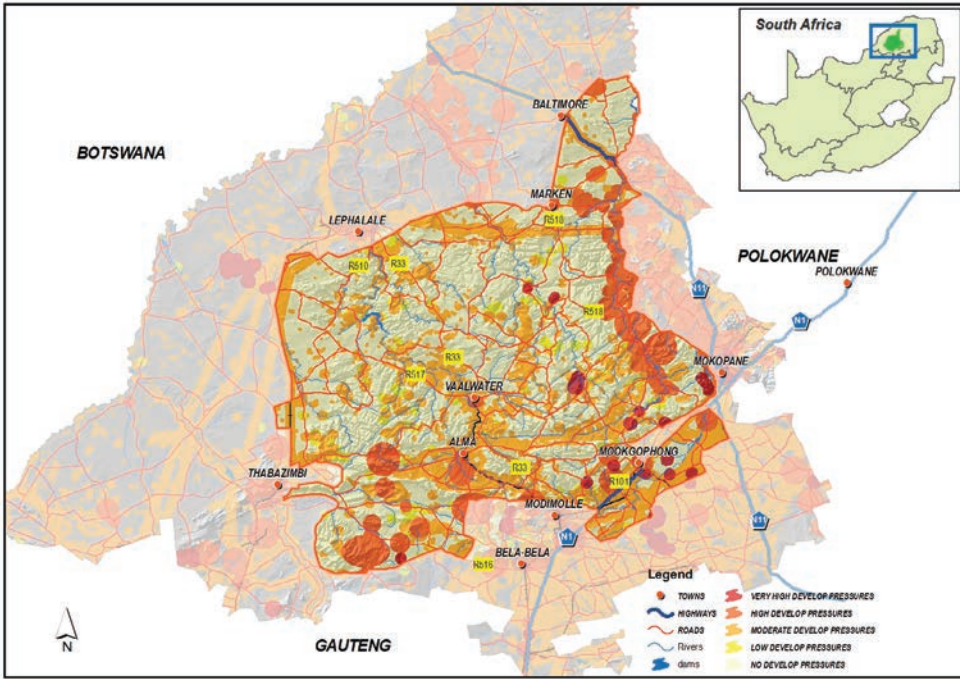


Figure 6: Areas of high development pressures in Exp-WBR

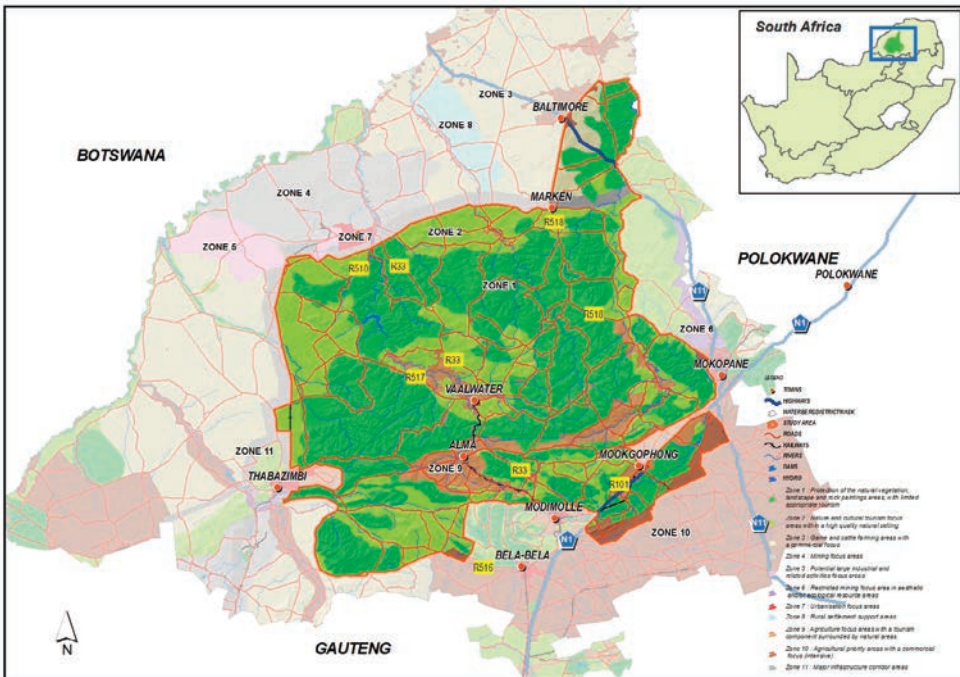


Figure 7: Waterberg District Environmental Management Framework in Exp-WBR

the Biosphere Management Plan (BMP) divides the Exp-WBR into four biosphere oriented zones:

- **Core**—securely protected areas for conserving biological diversity, monitoring minimally disturbed ecosystems, and undertaking non-destructive research and other low-impact uses;
- **Buffer**—adjoining the core areas, and used for co-operative activities compatible with sound ecological practices, including environmental education, recreation, ecotourism and applied basic research;
- **Transition 1**—containing a variety of agricultural activities, settlements and other uses in which local communities and other stakeholders work together to manage and sustainably develop the area's resources;
- **Transition 2**—as in Transition 1, but with less stringent restrictions on developments impacting upon the natural environment.

The BMP was able to relate the two systems by placing the Core and Buffer zones within EMF₁, the Transition₁ zone within EMF₂ and the Transition₂ zone within EMF₉. The distinction between Core and Buffer corresponds to those properties that are under formal conservation protection—either gazetted as national or provincial parks or private land under the stewardship programme, or contracted with the Biosphere Reserve to keep the property in conservation for the long term (20 years or more)—are designated as Core, while those that do not have this status or contractual obligation are designated as Buffer. It is worth noting that the Statutory Framework does not require that the Core be formally protected, simply that it be “legally constituted” (Stanvliet *et al.* 2004). For private landowners the designation of Core within EMF₁ is therefore purely voluntary and a reflection of a deep and on-going commitment to conservation of their property. The reward is international conservation status for their properties. As the precise areas to be designated Core in the pending application for expansion to UNESCO have not been determined as yet, the Core and Buffer Zones are not distinguishable in Figure 7.

The second distinction between the EMF and BMF is that while the former is couched in general terms, indicating which type of land use should be encouraged in each of the EMF zones, the BMF has developed clear unambiguous guidelines for each of its zones. These guidelines speak to issues such as land use types, density of tourism beds, footprints for lodges, height, parking, impacts upon rivers and dams, vehicle densities, subdivisions, building lines and guidelines relating to heritage resources, pollution and EIA issues. While seemingly restrictive, these guidelines are standard elements of any strategically planned landscape and are necessary to ensure the sustainability of the developing tourism industry in the future. The BMP has been adopted by the Waterberg District Council, and has already started to prove effective in guiding development in WMC. Significantly, officials who were previously party to approving a number of dense residential developments in the area have indicated that if such a spatial planning framework had been available at the time, many of their decisions would have been different.

The BMP will form the basis upon which an application will be made to UNESCO in 2013 for the expansion of the WBR. If successful, this will provide effective protection from inappropriate development to an incredibly important conservation area in South Africa. At the same time it will lay the foundation for a much expanded ecotourism sector based on a unique opportunity to experience African wildlife in a temperate, malaria free and easily accessible setting. Hopefully the raised conservation status of the area will serve as a catalyst for individual property owners to increase their levels of co-operation with one another, drop the many fences separating their properties and restore the WMC to some of its former glory as a true wilderness area where man's footprints were all but invisible.

5. Governance issues and projects identified

During the process of developing the BMP, the vision and mission of the Biosphere Reserve were reconfirmed.

The vision of the WBR is:

To maximize this unique area's considerable potential for not only conservation, sustainable development and social upliftment, but also research and education.

The mission of the WBR is:

- To build a conservation and sustainable-use ethic, by establishing and facilitating the implementation of a code of good practice which can then be effectively monitored;
- To promote appropriate and sustainable development, ensuring that the wilderness character and conservation value of the Waterberg as an important water catchment, natural resource and nature-based tourism destination is retained to the benefit of its people;
- To actively spread benefits and opportunities to poorer members of the community; and
- To facilitate relevant research, education and skills training in the area.

Similarly, the organization structure of the Reserve was reconfirmed. A stakeholder committee representing between 20 and 30 local interest groups elect an executive, who are then appointed as directors of a Not-for-Profit Company which acts as the implementing agent for Reserve projects. On the stakeholder committee a balance is required between government departments, municipal authorities etc. on the one hand, and civil society — NGOs, community organizations and representative bodies — on the other.

The specific priority projects that were identified to fulfil the mandate contained in the mission statement include the following:

- **Communication.** The WBR faces a complex interrelated set of challenges in fostering conservation and sustainable development in the area. Given the South African context, the stakeholders are diverse and often at odds with one another. The approach has been to develop a simple (although not simplistic) communication message that will enable the various role players to relate to, understand and

support the biosphere reserve. This is not an easy challenge. It has also been necessary to foster “ambassadors” for the biosphere reserve — respected individuals who can convey the message to their own communities. The WBR has also developed an extensive database to be used for direct communication with landowners, many of whom are not permanently resident in the area.

- **Skills training.** Given the dire need to improve employment levels amongst the WBR’s communities, particularly the youth, it has been necessary to develop projects aimed at providing improved educational results, skills and work experience for the upcoming generation. This has included the establishment of maths homework clubs, the delivery of ‘readiness for work’ courses and the implementation of a Youth Environmental Service project. Not all these jobs need to be in the conservation or nature based tourism sector. As noted previously, the WMC is in close proximity to one of South Africa’s fastest growing mining and energy generation nodes, and the increased number of jobs associated with this development should be accessible to the local population provided they have acquired the necessary skills. The advantage of this approach is that the Reserve is able to provide tangible benefits to some of the poorest members of the community, thereby increasing the relevance of the WBR’s existence to this stakeholder grouping who have little access to the conservation properties characterizing the Reserve.
- **Tourism development.** Having recognised the multiplier effect of developing ecotourism within the area on employment and the local economy, the WBR has set an objective to brand and promote the area as a preferred nature based tourism destination in the country and worldwide. This has entailed developing promotional material, including a dynamic website, and representing the area at travel shows and the like. In addition, the WBR has developed a tourism route through the WMC, called the Waterberg Meander, as a means to showcase the area and broaden the visitor experience.
- **Community tourism.** A key element of promoting tourism within the Reserve has been to assist with the development of community owned and operated tourism ventures. This has entailed raising the capital to provide infrastructure as well as mentoring and marketing services. In a context where practically all tourism businesses are owned by the previously advantaged, this project serves to bolster the notion that all elements of the community have a stake in the Reserve and should benefit from its international status.
- **Conservation of rivers and wetlands.** As a key source of water in a water scarce region, it is critically important to prevent the Reserve’s sensitive habitats being damaged by the invasion of alien plants. Through collaboration with Working on Water and utilizing the Youth Environmental Service project and its greater access to private properties as a community based organization, it is able to make a positive contribution.
- **Rhino protection.** The current rhino poaching crisis has indicated the need to use the Reserve’s position as a broad based organization with strong connections to government to assist with coordinating a collective response before it is too late.
- **Environmental education.** A core function of any biosphere reserve, environmental education through private organizations such as Lapalala Wilderness School

has a proud history in the WMC. The Reserve is seeking to support, promote and add to these initiatives.

6. Conclusion

The Waterberg Biosphere Reserve's recognition of the need for a management plan has taken the organization through a comprehensive socio-economic, environmental and spatial planning exercise. The ten years between the proclamation by UNESCO and the development of the management plan allowed for a detailed analysis of the issues in the WMC, lessons learnt, as well as the identification of the present and future challenges for the area. The result has been a carefully considered strategic vision for the Reserve supported by a new zonation scheme with sound scientific underpinnings, which is critical for the long-term sustainability and conservation of the WBR. The basis has been laid for a new application to UNESCO to greatly expand the Reserve, and thereby bring biosphere reserve status to the vast majority of the Waterberg Mountain Complex, and clear development guidelines have been developed for each of four zones within this Reserve. Finally, the management plan has provided focus for a series of priority projects aimed at addressing the particular challenges and opportunities facing the area, notably unemployment, threats to sensitive ecosystems, inequality and exclusion, and rhino poaching. Such a management plan can therefore become a critical tool in the biosphere context, not only by setting the agenda, giving guidance, considering lessons learnt, but also by integrating the biosphere reserve's aims and objectives with government planning and decision making instruments. The results, we hope, will be a well-functioning biosphere reserve, with a clear message and outline of responsibility that brings benefits to its communities while enhancing and protecting the environment.

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Natural Resources, People and Livelihoods in the Songor Biosphere Reserve

Ressources Naturelles, Populations et Moyens de Subsistance dans la Reserve de Biosphere de Songor

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Abstract

The Songor Biosphere Reserve is the second largest Ramsar site in Ghana and has a unique complex of diverse habitats, species and ecosystems of high economic, cultural and biological value. Species of value include marine turtles, mangroves, manatees, crocodiles, monkeys and water birds. The community-owned reserve has a population of about 42 150 who depend on the resources in diverse ways. An ecological survey conducted by the MAB Committee in 2009 as part of efforts to nominate the site as a UNESCO Biosphere Reserve, revealed an increasing trend of ecosystem degradation manifested by changing vegetation and land uses, invasive aquatic weeds, coastal erosion and siltation. Since the availability of reliable and up-to-date information is prerequisite to the effective management of natural resources, a socio-economic survey was conducted in 2010 to develop reference information for conservation and development. Information on the level of dependence on the resources as well as state of infrastructure and amenities was collated. 237 households from 28 communities were randomly sampled using a standard questionnaire. Focus group discussions were held with some local groups and institutions. A high level of dependence and awareness on the need to conserve resources were observed. The population deriving their livelihoods from the

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wetland resources had more than doubled in the past 10 years. Cultural systems were observed to play a major role in regulation. Increasing livelihood options and access to credits could significantly alleviate poverty and overexploitation of the resources. Recommendations have been provided to address the challenges of management. With the enlistment of Songor on UNESCO's World Network of Biosphere Reserves, the information generated will provide a sound basis for project formulation as well as to facilitate the monitoring and evaluation of projects.

Key Words: Community-owned, degradation, information, regulation, challenges, monitoring, biosphere reserve

Résumé

La Réserve de biosphère de Songor est le deuxième site Ramsar le plus important au Ghana, présentant un complexe unique composé d'une diversité d'habitats, d'espèces et d'écosystèmes de valeur économique, culturelle et biologique importante. Parmi les espèces, on peut noter les tortues marines, forêts de palétuviers, lamantins, crocodiles, singes et oiseaux aquatiques. La réserve est détenue par la communauté et accueille une population d'environ 42,150 habitants qui dépendent des ressources de diverses manières. Une étude écologique menée par le comité du MAB en 2009 dans le cadre des efforts de nomination d'un site classé comme Réserve de biosphère par l'UNESCO a révélé une tendance à l'accroissement de la dégradation de l'écosystème manifestée par un changement de la végétation et de l'utilisation des terres, l'invasion par les herbes aquatiques, l'érosion côtière et la sédimentation des vases. Etant donné que la disponibilité d'informations fiables et actualisées est une condition pour la gestion efficace des ressources naturelles, une étude socio-économique a été menée en 2010 pour développer des informations de référence visant la conservation et le développement. Les informations sur le niveau de dépendance des ressources ainsi que l'état de l'infrastructure et des installations ont été compilées. 237 ménages de 28 communautés différentes ont été échantillonnés de manière aléatoire en se basant sur un questionnaire standard. Des discussions de groupes-témoins ont eu lieu avec des groupes locaux et des institutions. Un fort niveau de dépendance et une sensibilisation sur le besoin de préserver les ressources ont été observés. La population dont les moyens de subsistance découlent des ressources des régions marécageuses a plus que doublé au cours de la dernière décennie. Il a été constaté que les systèmes culturels jouaient un rôle crucial dans la réglementation. L'amélioration des options de moyens de subsistance et de l'accès aux crédits pourrait réduire la pauvreté et la surexploitation des ressources de manière significative. Des recommandations ont été prodiguées pour faire face aux enjeux de la gestion. Grâce au classement de Songor sur le réseau mondial des réserves de biosphère de l'UNESCO, les informations recueillies apporteront une base solide pour la formulation du projet tout en facilitant le suivi et l'évaluation des projets.

Mots-clés: Propriété communautaire, dégradation, information, réglementation, enjeux, suivi, réserve de biosphère

1. Introduction

Natural resources are exploited throughout the world to meet various national and international development goals. In developing countries like Ghana, the dependence on these natural resources is relatively higher due to increasing populations leading to overexploitation for food, fodder, raw materials for industry and other socio-economic and cultural services. The obvious consequence is resource degradation with serious threats to the ecological integrity of vital ecosystems, the very same systems which support all forms of life. For rural communities, loss of livelihoods is the most crucial challenge since a majority lack the capacity or resources to adapt and is often vulnerable to phenomena such as climate change, droughts and desertification. This underscores the need for collaborative management approaches that ensure adequate community involvement in resource management which ensures that people are informed about the dynamics between their socio-economic activities and the natural resources.

UNESCO, through the Man and the Biosphere (MAB) Programme, proposes a global interdisciplinary research agenda and capacity building which targets the ecological, social and economic dimensions of biodiversity loss and the reduction of this loss. Natural and social sciences, economics and education are integrated to improve human livelihoods and safeguard natural ecosystems, thus promoting innovative approaches to economic development. Biosphere Reserves are used as laboratories for implementation of interdisciplinary initiatives to model the harmonic co-existence of man and nature. They are terrestrial and aquatic sites that are intended to serve three main functions:

- contribute to biodiversity conservation;
- foster sustainable socio-economic development; and
- provide support for research, monitoring, education and information exchange on issues relating to conservation and development at the local, national and global scales.

At present, the World Network of Biosphere Reserves (WNBR) has a membership of 580 sites in 114 countries which are considered as sites of excellence where new and optimal practices to manage nature and human activities are tested and demonstrated (UNESCO 2011a).

Until June 2011, Ghana had one biosphere reserve, the Bia Biosphere Reserve located in the Juabeso and Bia districts of the Western Region and designated in 1983. It consists of the Bia National Park (core area of 7 800 ha), the Bia Resource Reserve (buffer zone of 22 800 ha), about 43 neighbouring communities and two forest reserves (transition area of 83 700 ha). The Bia reserve, with the assistance of UNESCO, has played a major role in the reorientation of communities to feel a collective sense of ownership for the management of the natural resources. Interventions in the form of alternative livelihood introduction and support for value addition to existing livelihoods were introduced which reduced pressure on the resources and enhanced the relationship between the management authority for protected areas in Ghana, the Wildlife Division and the communities. Additionally, the Protected Areas Development Project has improved the participation of communities in management through the introduction of Community

Resource Management Areas (CREMAs) which have oversight responsibility over the forest resources in the transition zone (Wildlife Division 2010). This has further enhanced cooperation with management. However, some problems still pertain due to the zonation system which still does not conform to that prescribed in the Seville Strategy of 1996 (UNESCO 1996). Based on the experiences in Bia, it was imperative that all subsequent biosphere reserves meet the Seville prescription to facilitate proper functioning.

The Songor Biosphere Reserve, located in the Dangbe East District of the Greater Accra Region, began its journey to the WNBR when the UNESCO's Natural Sciences Sector as part of its main lines of action provided support for countries to increase the number of biosphere reserves in the world as a way of promoting the MAB concept in the 2008–2009 biennium. The Songor Ramsar Site was selected from among 17 sites and, following ecological studies in 2009, nominated by the MAB Committee in 2010. It was enlisted in June 2011 by UNESCO. Though community-owned, the zonation conforms to the Seville prescriptions and Target 13 of the Madrid Action Plan for Biosphere Reserves (MAP 2008–2013 — UNESCO 2008) which requires a functional zonation in all biosphere reserves established, particularly with regard to the transition area and the development function. Additionally, in line with efforts to implement as many targets of MAP as possible, a medium term objective of the MAB committee of Ghana is to enhance public awareness on the biosphere reserve concept, to ensure its integration into other sustainable development initiatives, to increase the number and coverage of biosphere reserves as well as the number of activities implemented by the MAB national committee. The availability of a reliable and up-to-date information base is prerequisite to the effective management of natural resources because it demands knowing what is being managed, how it is being impacted by various internal and external drivers and also determines interventions for management as well as the effects of management actions. However, in spite of the numerous studies undertaken in Songor under the Coastal Wetlands Management Project in the mid 1990s, there is still no collated documentary base relating to the social structure of the communities. A socio-economic survey was therefore conducted in 2010 by the MAB committee to initiate an information base by eliciting information on the socio-cultural characteristics, environmental characteristics and the economic and productive systems. This was an initiative to fulfill target 16.2 of the MAP which calls for improved access to information and new ways to communicate knowledge to a large variety of non-scientific target groups. The initial results were validated in a stakeholder workshop in May 2011 (Ashong 2011).

In this paper, some of the baseline information gathered by the MAB committee of Ghana on the socio-economic status of communities in the Songor Biosphere Reserve is reviewed in order to provide answers to the following questions:

- (i) How dependent are the communities in Songor on the natural resources?
- (ii) What are the main sources of livelihood in Songor?
- (iii) What are the alternative livelihood options to be considered for the reduction of pressure on the resources?

- (iv) How does the membership of the WNBR and consequently, the African network, AfriMAB, translate to enhancing the welfare of communities in Songor?

The objectives were to assess:

- the communities, their livelihood activities and how these impact on the reserve;
- the implications of Songor's enlistment as a UNESCO biosphere reserve for enhanced management; and
- the potential contribution of Songor to the functioning of the African Network of Biosphere Reserves, AfriMAB.

2. Population and biodiversity of the Songor Biosphere Reserve

The Songor Biosphere Reserve, Ghana's first coastal biosphere reserve, is a community-owned reserve where all the resources, including the lagoon and portions of the estuary, are owned by clans where elders serve as custodians who sell or lease land (Ofori Danson 1999). The indigenous people are predominantly Adagmes with a lower percentage of Adas and the minority Ewes. The main languages spoken are Ga and Ga-Dangbe. With a population of about 42 000 (Statistical Services Division 2000), the people are involved mainly in subsistence crop farming, animal rearing, fishing, hunting, salt mining during the dry season and fuel wood collection. The communities are known for their strong indigenous values which are manifested in the effectiveness of traditional regulations, and which support conservation and the presence of several sacred groves. The area is considered one of the top national tourist destinations, particularly during the celebration of the annual Asafotufiam festival.

As the second largest Ramsar site in Ghana, provisions for protection are covered under the Wetlands Management (Ramsar) Regulations, 1999, LI 1659. The management authority is the Wildlife Division of the Forestry Commission. A combination of riverine, brackish/estuarine and marine ecosystems and islands, provides formidable support for biological diversity. The Songor lagoon and its floodplains provide feeding and roosting sites for water birds, while the coastal stretch provides as nesting sites for marine turtles and fish species, with Agave island providing a habitat for mangroves and monkeys. The Songor Biosphere Reserve is home to three species of marine turtles, two species of mangroves, one species of manatee, three monkey species, 15 species of fish and 42 species of water birds. The distribution of the various organisms is presented in Figure. 1.

The main challenges induced by human activity are pollution, habitat modification for agriculture, proliferation of invasive weeds, predation on turtle eggs by dogs, poaching and littering. Enforcement of the National regulations is ensured by the Wildlife Division and complemented by traditional regulations and community education to control these challenges. However, coastal erosion is a major threat to shoreline stability with an increasing trend that has been linked to climate change (MAB National Committee 2009).

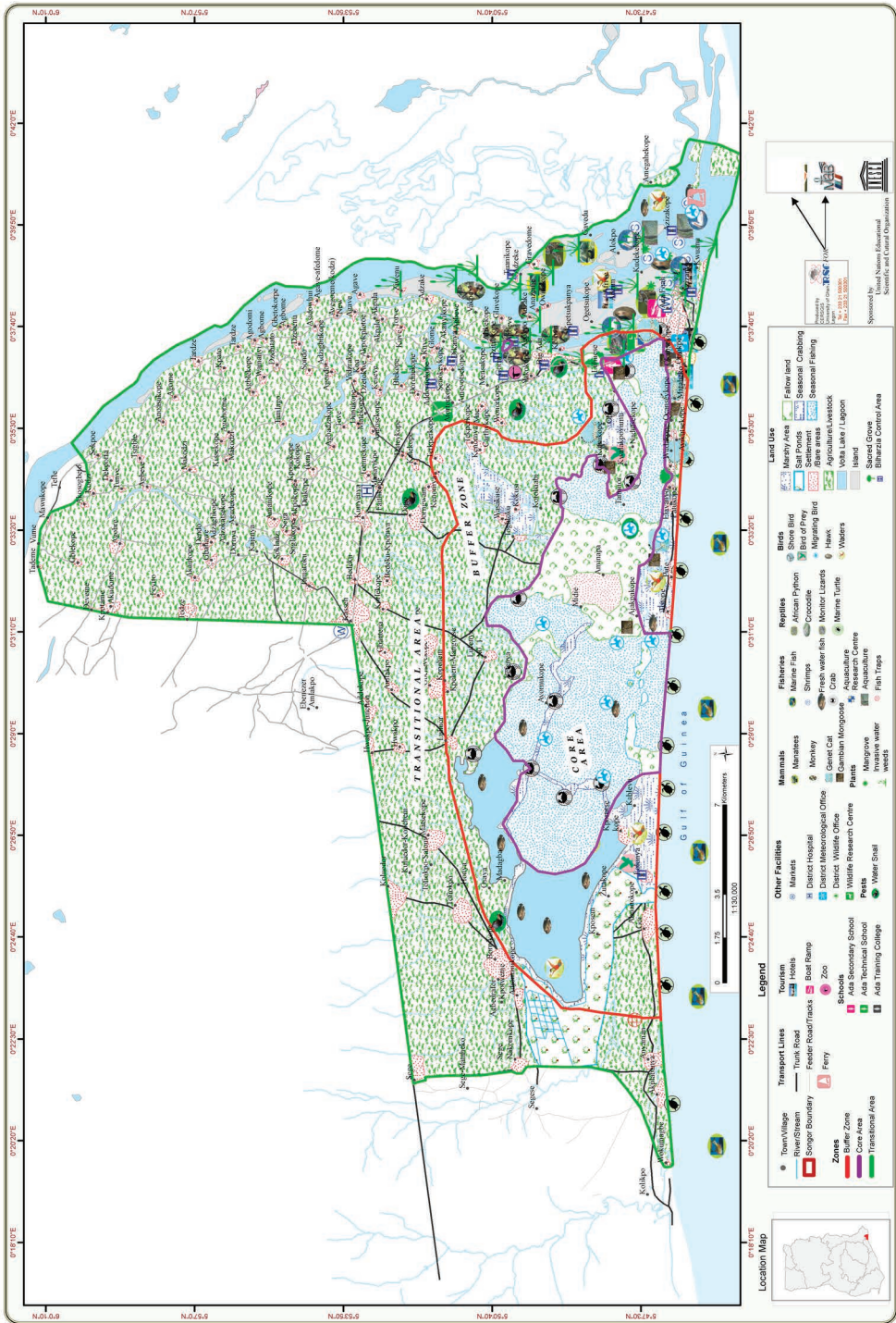


Figure I: Ecological map of the Songor Biosphere Reserve

3. Study area and methods

3.1 Study Area

The Songor Biosphere Reserve lies between latitudes 06°00' 25" N, 00°19' E and 05° 45' 30" N, 00°41' 40" E and has a total area of 51 113.3 hectares: core area of 8 238.04 ha, buffer zone of 11 490.47 ha and transition area covering 32 941.95 ha. The survey was conducted in 28 randomly selected communities in the three zones (Figure 2).

3.2 Methods

Household surveys and focus group discussions were held to elicit information on the socio-cultural characteristics, economic and productive systems and environmental characteristics using a semi-structured questionnaire. The focus group discussions were held in seven communities: Gorm, Pute, Totokpoe, Lolonyakope, Tekpekope, Togbloku, Obane and Wassakuse. Representatives of key institutions such as the District Education Directorate, District Office of the National Fire Service and the District Health Directorate were also interviewed. A total of 237 questionnaires were administered. Information was elicited on resource diversity, natural resource use, environmental change and quality, and land use/farming, options available for cottage industries as alternative livelihoods, cultural systems for conservation among others.

4. Results

4.1 Livelihoods and their impacts on wetland resources

A high level of dependence on the resources of the wetland was observed because the population dependent on the wetland resources had more than doubled in the past ten years. All respondents of the household surveys acknowledged the use of the resources for food, meat, income and energy generation. Fishing and farming were the most important activities supplemented by hunting, fuel wood collection and trading. About 93% were however involved in one main livelihood activity, with the rest taking advantage of seasonal changes to indulge in other activities. 40% of the people had been involved in the current livelihood activity for at least ten years. There had been previous support from institutions like Banks (20.0%), the District Assembly (8.0%), and the Wildlife Division under the Community Investment Support Fund (CISF), 44%, for the improvement of the livelihood activities. The remaining 28% had received support from other sources.

4.1.1 Fishing

The high incidence of fishing (including fish mongering) as a livelihood activity (84.5%) despite the fact that 62.9% were aware of the national and traditional regulations was a source of concern. Traditional fishing regulations included no-fishing days, which varied depending on the community. No-fishing days were mainly on Tuesdays and when there was a funeral in the community. Other combinations of no-fishing days were Tuesdays and Fridays; Thursdays; or Thursdays and Fridays. Other traditional

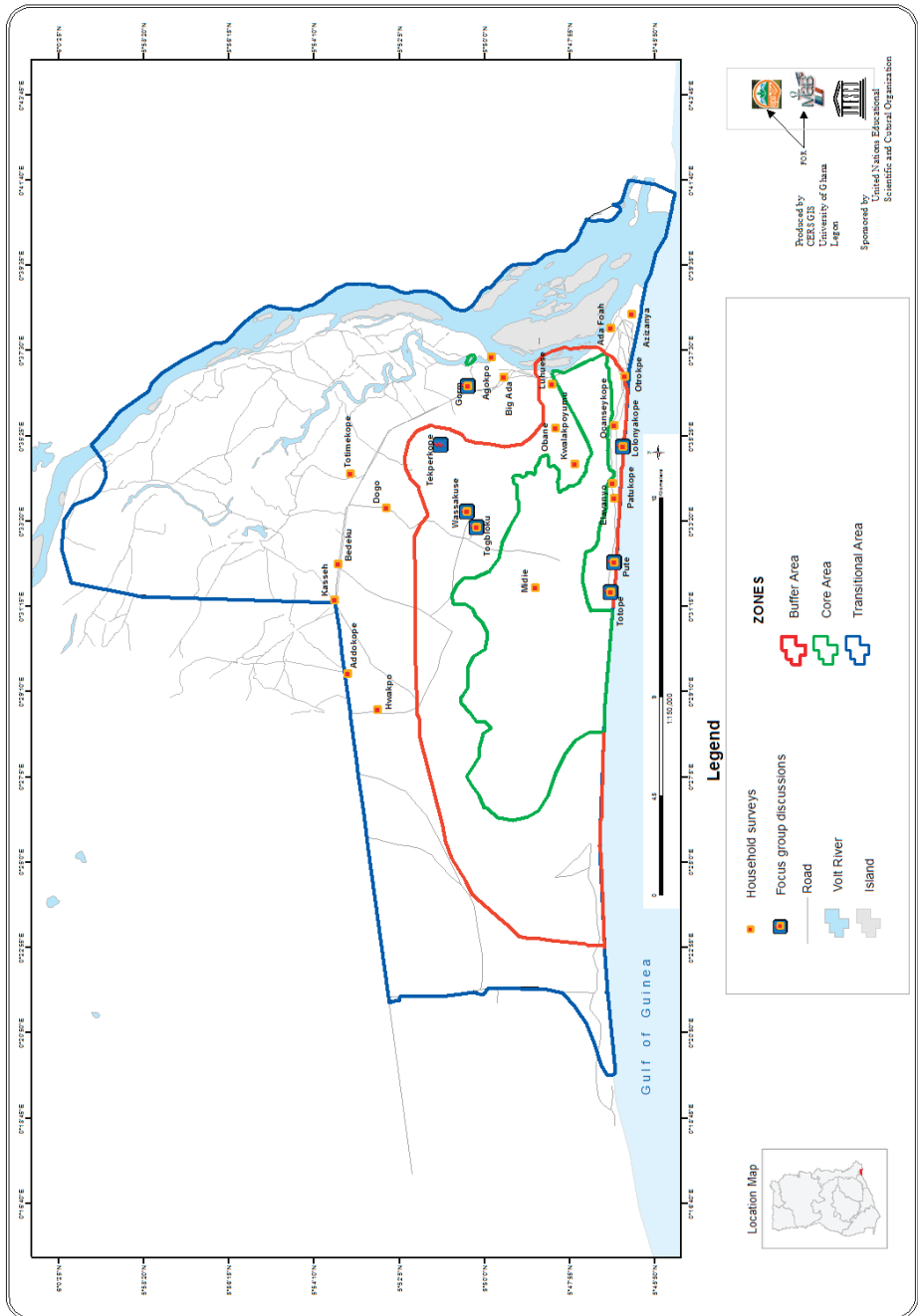


Figure 2: Communities covered during the socio-economic survey of the Songor Biosphere Reserve

rules included the performance of rituals before fishing, no bathing of animals in the water, and no lighting on the beach. The Fisheries Act of Ghana Act 625 of 2005 and the Fisheries and Aquaculture Regulations LI 1968 of 2010 make prescriptions for the restricted access to certain areas, approved mesh sizes for fishing (such as the cast net), bans on fishing of fingerlings, light fishing and the use of chemicals.

4.1.2 Farming

Two-thirds of the respondents (67.8%) were farmers, with a large percentage owning either all (52.2%) or some (23.6%) of the lands cultivated. The number of farms that were cultivated by the respondents varied, with a large majority farming between 2 (30.8%) and 3 (28.8%) plots each. Respondents indicated that they had indeed observed some deterioration in the quality of land over the past 20 years in the form of reduced land cover, usually as a result of deforestation and degraded vegetation cover. Land fertility had progressively reduced even with the continued use of fertilizers, as nutrient content is diminishing and the area of bare soil increasing. This confirms the observations of the MAB national committee in 2009 of a reducing trend from 1999 in bare soils and built up areas at the expense of vegetated areas. Hardening of soil, increased acidity and salinization had also been observed by the farmers.

The main crops cultivated included cassava, maize, tomatoes, pepper and water melon. Others were onions, garden eggs, okro, beans, sugar cane and rice. Land was initially cleared with using hoes and cutlasses, and where affordable, tractors were used to plough. As practised by most Ghanaian farmers, farmers allow fallow periods until the following rainy season. Respondents indicated various fallow periods from between three months to two years, depending on the crops grown. During fallow periods, other lands were farmed or farmers were engaged in other types of livelihood, such as selling of fish. In some instances, crop rotation was practised.

Two-thirds of the respondents used fertilizers (69.4%) and pesticides/herbicides/fungicides (73.4%) to improve and protect their crop yields. For those who used no fertilizers, this was attributed to the cost of the fertilizers. A small minority was of the opinion that there was no need for these chemicals as the land was fertile enough. Respondents were generally of the view that the fertilizers improved soil fertility and increased production although a few observed that with increased use, the soil became weak, leading to reduced yields. They also conceded that the positive impacts of pesticide use, which limits the degree of crop damage by insects, had some environmental impacts such as reduced water quality.

Livestock rearing was also practised by more than half of those interviewed (57.8%), with many of them (53.4%) aware of regulations involving the watering and grazing of livestock. Usually this involves keeping the livestock close to the homes and away from the farms. The majority accepted the relevance of these regulations. Livestock manure was not widely recycled as fertilizer, although many livestock owners have farms. The main reason was that the manure was not enough to contribute to crop production. Most of the manure was therefore burnt or disposed of in public dumps.

4.1.3 Firewood collection and charcoal production

Firewood and charcoal served the energy needs of more than 90% of the respondents, with a combination of the two being the most commonly used (52.5% — Figure 3). Charcoal production in the communities was however minimal (only 19.1%). 20% accepted that charcoal production could have negative effects on human health and the environment through deforestation and reduced vegetation, hardening of soil due to charcoal burning, and air pollution.

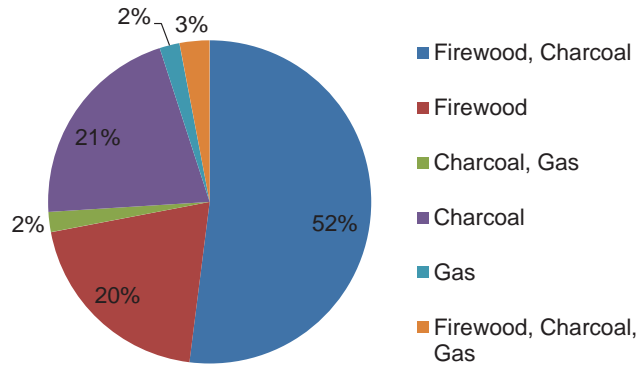


Figure 3: Domestic sources of energy in the Songor Biosphere Reserve

4.1.4 Hunting

In various communities, hunting was done to supplement the protein diet. 32.3% of the respondents indicated that they hunt wild animals to supplement their diet and as an extra source of extra income at times. Within each community, there were usually less than ten hunters (40% of the respondents indicated such), and less frequently ranged from 11–20 hunters per community (according to 14% of the respondents).

The most common hunting method used was the trap method (46.2%), although hunters also used guns (20.0%) or a combination of both (13.8%). The Grasscutter or ‘Akrantie’ was the most exploited (Figure 4).

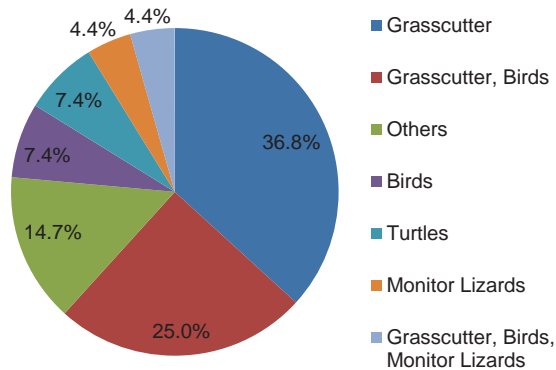


Figure 4: Exploitation of wild animals in the Songor Biosphere Reserve

4.1.5 Traditional practices that support conservation

21.7% of respondents indicated an awareness of protected or sensitive sites in their community, whilst 67.8% were not aware and 10.6% were not sure. These community protected areas included: Yesoh for protection of fish, Kokuse for the White Mangrove; Abordohue; Tele Musuku; Okorhwe near Goi; Nartey's land; Kokohuwe, Opoku Kpohuwe; Agbepienya; Abordohwe; Abordolive (believed to be a Dwarf Haven); Abodorhwe and Okorlwe. These areas are protected by traditional laws which ensure that that no one had the right of entry except for the fetish priest, or where some access was allowed but with a ban on activities like tree-felling and fetching of water. In addition to the traditional sacredness of these sites, they were also important in environmental protection and biodiversity conservation.

4.2 Gender and natural resource use

Natural resource collection is an activity that occurs throughout the year, although some activities are more regular either in the rainy season or the dry season. The responsibility of collecting these resources is shared between males and females, with occasional participation by youth, depending on the type of natural resource. For example, resources such as wild animals, fish, palm thatch, bamboo, honey, palm wine, pestles (“fufu sticks”), and ‘Akpeteshie’, a local brand of gin, are collected mostly by men. Water and charcoal was usually the responsibility of women, with the collection of snails, medicinal herbs, fruits, mushrooms, mangroves, reeds, and salt were usually done by all. However, the men still played the most significant role in the collection of mangroves and reeds (Figure 5). Most of these resources were used either for domestic consumption or were sold for extra income.

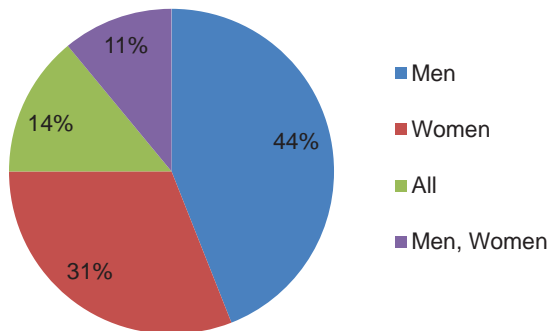


Figure 5: Gender roles in harvesting of Mangroves in the Songor Biosphere Reserve

4.3 Available options for alternative livelihoods

The main challenges with viability of the current livelihoods were lack of capital for increased investment. The options for alternative livelihoods suggested by the respondents varied widely and included: carpentry, masonry, mat weaving, tailoring, agro-processing (gari, fruits and vegetables), grain milling, soap, traditional garment

manufacture (beads and tie-and-dye), aquaculture, and basket weaving. However, the majority indicated their activities were currently non-profitable and they were willing to change to alternative livelihoods if support was provided (Figure 6). They had not ventured into other alternatives because of lack or inadequacy of capital as well as lack of storage and processing facilities for the products and lack of access to credit schemes for the expansion or revitalization of their current livelihood activity, or no training in management of the activity. Attempts by the Wildlife Division to assist through the production of small loans had failed due to the inability of most beneficiaries to repay.

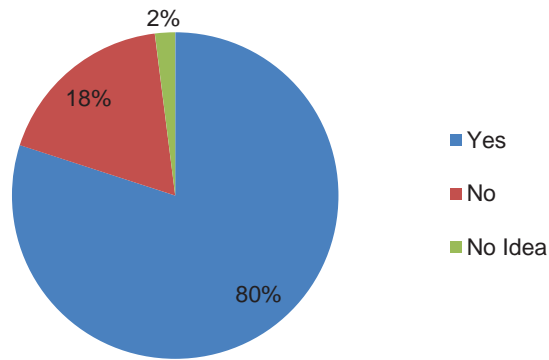


Figure 6: Willingness of people in the Songor Biosphere Reserve to change their livelihood activity with the provision of support

4.4 Social services

Most people used orthodox medical care and were registered under the National Health Insurance Scheme, though traditional medicine and some private clinics were available. The presence of only one major hospital i.e. the Ada Government Hospital was a major setback to health care delivery.

For water supply, the Community Water and Sanitation Agency had provided some stand pipes, which was used by about 40% of respondents leading to a reduced incidence of water borne diseases. Water supply was generally not a problem (Figure 7). The other sources of water were bore holes and wells with a small minority being dependent on river and stream water (7.1%). There were however problems with salinity of the water from the boreholes and wells. Most households covered short distances to the water source. Most respondents (88.1%) walked less than two kilometers to the source of water. 2% were 5 km or more away from the water source, 5.8% travelled between 2 km and 5 km, while 4% travelled about 3 km to their water sources (Figure 8).

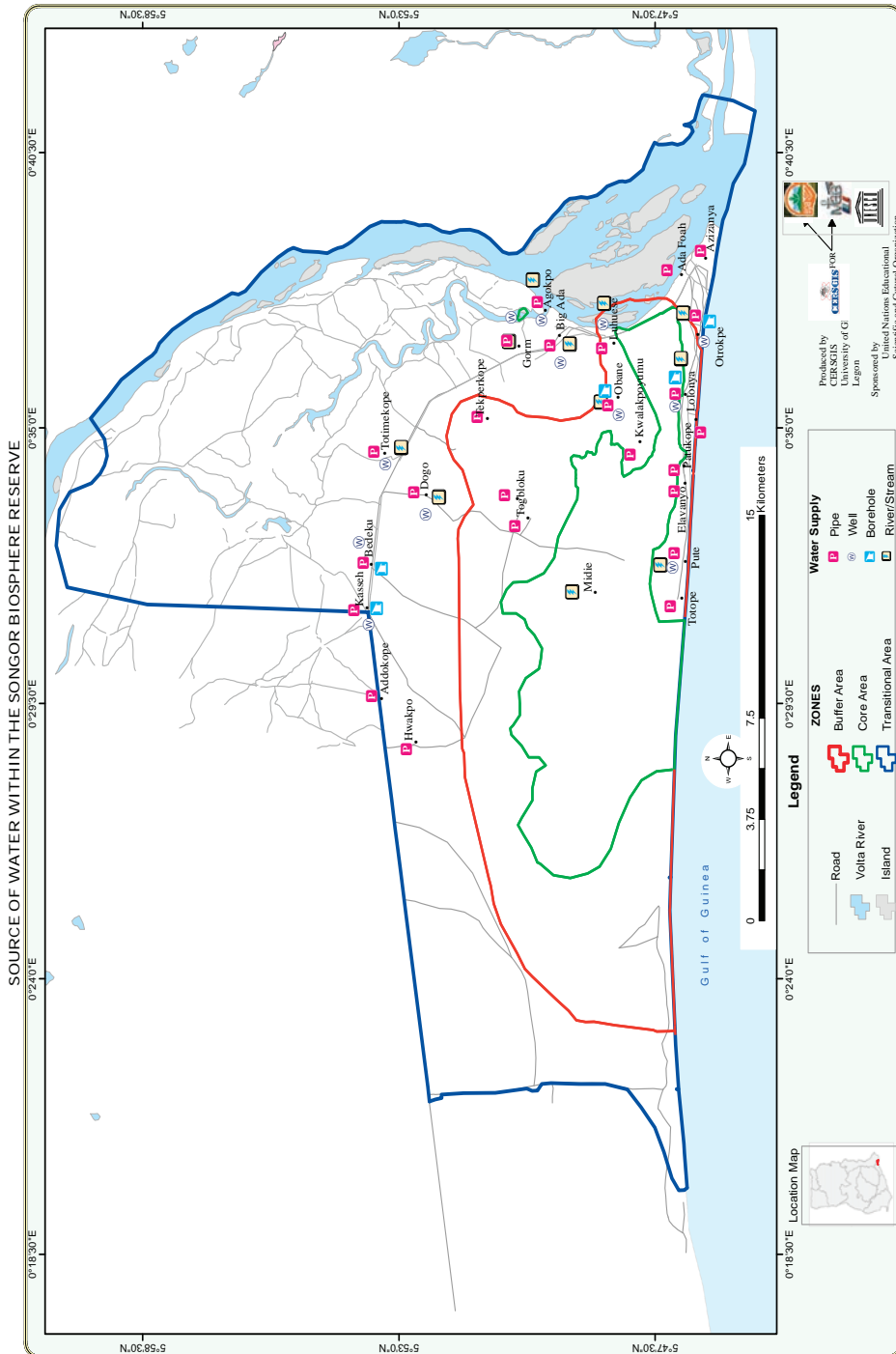


Figure 7: Sources of water available to communities in the Songor Biosphere Reserve

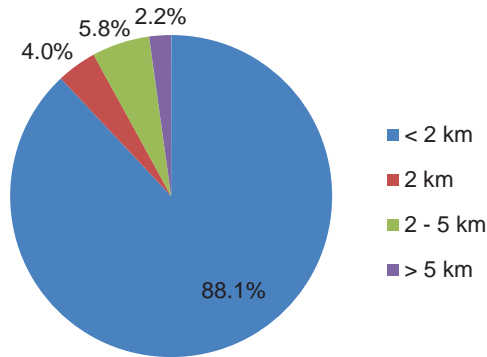


Figure 8: Distance travelled by respondents to the source of drinking water

Problems were encountered with waste disposal (solid and liquid wastes). Waste containers had been provided by the District Assembly for the communities. Some were also disposed of by burning. Zoomlion, a private waste management company and its subsidiary, Zoil (specializing in beach cleanup), had set up offices on site. However, due to poor drainage, liquid wastes and improperly managed solid wastes often became breeding grounds for vector diseases such as malaria.

Except for the main road leading to the town, the road network was generally poor and therefore inhabitants often had to walk long distances to the markets, school and health facilities. The road network which was susceptible to deterioration in the wet season provided further challenges for health workers who visited the communities to render health services.

4.5 The impacts of tourism on human welfare

The majority of the respondents (91%) believed that tourists visit the site mainly to see the wetland and its wildlife as well as the Asafotufiam festival. Tourism had largely impacted positively on the lives of many. Sixty-one percent (61%) of respondents had had their lives enriched through tourism activities. Human behavior and social lives had been altered through the development of new attitudes. New friends and establishment of new relationships had been achieved by 48% of respondents. However, less than 8% had gained employment through the livelihood activities.

4.6 Environmental education, social groups and festivals

More than half of the respondents (57.0%) belonged to various social groups. Most of these (66.9%) were religious organizations. 13.8% of the respondents belonged to recreational groups, 7.7% belonged to interest groups comprising migrants and women's groups, while less than 2.5% belonged to recreational, religious or political organizations. All members of the organizations seemed to have a fair knowledge of the need for conservation. Over 73.1% indicated that issues of conservation had in one way or another been discussed by the organization. The remaining 26.9% had not been involved in any group discussions concerning environmental conservation.

Festivals were observed to play an important role in awareness creation. 93% of respondents had acquired more knowledge about environmental conservation during festive occasions. They therefore considered festivals as good platforms for environmental education.

4.7 Translation from enlistment as a UNESCO Biosphere Reserve to enhancement of community welfare and improvement of the natural resources

The biosphere reserve concept presents added opportunity to enhance socio-economic development alongside conservation. This could be done through the implementation of community-based projects. The presence of organised social groups such as cooperatives in each community, provided a good basis for mobilisation in self-help projects for community development. This is especially applicable to gender based groups. The focus group discussions underscored the information gathered during the household surveys with the following issues being flagged for serious consideration by all stakeholders:

- (i) Though Songor is a major tourist and research centre, the standard of living of the indigenous people is generally low.
- (ii) There is more room for improvement of infrastructure and services.
- (iii) The people had a cordial relationship with the local government authority which is responsible for the provision of social services.
- (iv) The numerous organised community groups (gender-based groups, recreational groups, religious groups) provided a good entry point for environmental education and support for community welfare enhancement.
- (v) There was very low awareness of the MAB programme and the role of biosphere reserves in modelling sustainable development.
- (vi) There was a high expectation on the part of respondents that enlistment on the WNBR would translate to enhancement of their livelihoods and improvement of the natural resources (Ghana MAB National Secretariat 2011).

For Songor to fulfill its three functions as a biosphere reserve, further studies on alternative livelihood options suggested by the communities and the feasibility of their implementation should be considered as crucial, since this presents the most viable solution to reduction of the dependence on the resources. Priority should be given to tourism-based activities like beads making and tie-and-dye production as well as the agro-based enterprises that would ensure value addition to the agricultural produce while creating new jobs throughout the year. The private sector could be engaged to help promote marketing of products like honey, beads and fabrics at the national and international levels. The gains from these collective projects could then be used to improve infrastructure and services in the communities as has been done in the Adjoafua community in the Bia Biosphere Reserve (Ghana MAB National Secretariat 2010). This should be done in close collaboration with the District Assembly that is well placed to source funds for development projects. The site management committee should be empowered and assisted to source funds from donors to implement community based projects for

livelihood training or improve the capacity of community members to sustain their livelihoods. It would also be necessary for the Wildlife Division to cooperate with appropriate financing institutions to provide access to credit schemes and training in income generation activities. In all these instances, priority should be given to the preferences of the people.

Secondly, there would be the need for increased publicity on the logistic function and potential of the site for climate change adaptation studies. In view of the UNESCO's theme for its 40th anniversary celebration, "For Life, for the Future, Biosphere Reserves and Climate Change", the opportunity must be taken to sensitize research institutions, universities and other organizations to mobilise resources to conduct studies especially for climate change mitigation and adaptation on site, in line with recommendations of the Dresden Declaration on Biosphere Reserves and Climate Change (UNESCO 2011b). Publicity features such as documentaries, radio jingles and television advertisements, fliers and posters would be a good medium for communication. As far as possible, community members should be involved since they have a wealth of traditional knowledge that can contribute to conservation research. The results of such research should be published and made user friendly. Support should also be provided for improvement of monitoring, especially for mangroves, monkeys and turtles.

Thirdly, traditional gatherings, especially festivals, should be used as a forum for education on issues like climate change, prevention of bush fires, waste management, overfishing and the observance of closed seasons. These would also be good opportunities to sensitize members on the MAB programme, the biosphere reserve concept and its role in modelling sustainable development.

During the impending revision of the site management plan by the Wildlife Division, the long and short term impacts of climate change should be integrated for the development of appropriate interventions for mitigation and adaptation for all vulnerable groups. This would require maximum stakeholder participation. The District Assembly could source funding for adaptation projects from the Africa Adaptation Programme of the Environmental Protection Agency.

Finally, the capacity of the Wildlife Officers to enforce the Wetlands Regulations of 1999 should be improved through increase in the staff strength, infrastructure and organization of regular training exercises. The Environmental Protection Agency and the Minerals Commission would also be expected to ensure compliance with the Environmental Assessment Regulations of 1999, LI 1652 and the regulation of salt mining during the dry season in the transition zone. Traditional leaders, particularly those actively involved in conservation programmes, should be empowered to keep enforcing the traditional regulations which are considered to be more effective than the national regulations. This would also reinforce the sense of ownership and responsibility on the part of community members for the maintenance of the ecological and economic integrity of the ecosystem.

4.8 Implications for the AfriMAB Network

The inter-relationships among the natural resources, people and livelihoods in the Songor Biosphere Reserve have several implications for the African Network of Biosphere Reserves (AfriMAB) including the following:

- (i) In line with target 28 of MAP 2008, the opportunity for sharing the information gathered and experiences with management should be shared through the provision of support for exchanges with other biosphere reserves in the sub-region. Twinning with the Saloum Delta Biosphere Reserve in Senegal should also be explored to enhance the capacities of the site managers to address their management challenges. The possibility of having partnerships for water and/or forest funds for mangroves could also be explored.
- (ii) Songor could be considered for selection to develop an assessment of its contribution to local economies in collaboration with the local communities. This would ensure profitability and sustainability of livelihoods, establishment of partnerships and the economic empowerment of vulnerable groups in the society.

5. Conclusion

The survey has generated useful baseline information for consideration in future activity implementation. It has also brought to the fore the development needs of the communities and their living conditions which, to a large extent, influence their relationships with the natural resources.

6. Acknowledgements

We are grateful to all who contributed in the data collection and analysis, particularly the assemblymen, community volunteers and opinion leaders of Songor.

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Managing Threats to the Middle Zambezi Biosphere Reserve

Gérer les menaces de la réserve de biosphère du Moyen Zambèze

CHRIS H.D. MAGADZA¹

Abstract

The Middle Zambezi Biosphere Reserve (28°E: 30°E; 15:30S: 17:20S) is the first biosphere reserve to be proclaimed in Zimbabwe. It is located in the Zambezi valley at between 300 and 700 m above sea level and constitutes the westward extension of the East African rift valley. Totalling 2 161 696 ha in area, 83% of it comprises the core and buffer zones, where major land use is wildlife management and some agriculture. Habitat diversity varies from plateau *Brachystegia* woodlands, escarpment woodland, *Combretaceae* woodland, valley *Mopane/Combretaceae/Adansonia* woodland, riverine forest and a part of an artificial inland lake (Lake Kariba). Instrumental and climate model data indicate that the Zambezi Valley is warming at a faster rate than the surrounding landscape. Impacts of climate change have already been detected in the aquatic ecosystem. The valley therefore offers unique research opportunities for studying impacts of global warming in rift valley systems. The creation of Lake Kariba, the largest man-made inland sea, at a time when environmental and social impacts of such development were unknown, revealed multiple impacts. The biosphere reserve has a unique record of both human and environmental impacts of large dam projects.

Apart from global warming threats to biodiversity in southern Africa, human pressure on natural resources is an intensifying threat to biodiversity in the region. In the Zambezi valley illegal hunting for wildlife products, such as rhino horn and elephant tusks, has shown that species can be driven to the brink of extinction in a very short period. Useful experiences in management strategies to cope with this threat in the Middle Zambezi Biosphere Reserve can contribute to this global threat to biodiversity. This has consisted of, on the one hand resolute determination to fight crime, as well as creating an environment for local communities to realise the economic value of biodiversity. The overall value of the Middle Zambezi Biosphere Reserve to economic development is briefly discussed. The Middle Zambezi Biosphere Reserve also incorporates the Mana Pools and Chewore World Heritage sites.

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Key words: Middle Zambezi Biosphere Reserve; Zambezian and Mopane woodland Ecoregion 54; World Heritage; climate change impacts; Lake Kariba; involuntary resettlement; pest management; biodiversity threats; human–wildlife interactions

Résumé

La réserve de biosphère du Moyen Zambèze (28°E: 30°E; 15:30S: 17:20S) est la première réserve de biosphère à être proclamée au Zimbabwe. Elle est située dans la vallée du Zambèze à une altitude de 300 à 700 m au-dessus du niveau de la mer et constitue l'extension vers l'ouest de la Rift Valley de l'Afrique orientale. Totalisant 2,161 696 ha de superficie, 83% se compose des zones centrales et tampon, où l'utilisation principale des terres repose sur la gestion de la faune et un peu d'agriculture. La diversité de l'habitat varie des forêts de *Brachystegia* du plateau aux escarpements boisés, forêts de *Combrétacées* à celles de *Mopane/Combrétacées/Adansonia*, la forêt riveraine et une partie du lac intérieur artificiel (Lac Kariba). Les données du modèle climatique et instrumental indiquent que la vallée du Zambèze se réchauffe à un rythme plus rapide que le paysage avoisinant. Les impacts des changements climatiques ont déjà été détectés dans l'écosystème aquatique. Par conséquent, la vallée offre des opportunités uniques de recherche pour l'étude des impacts du réchauffement de la planète dans les systèmes de la Rift Valley. La création du Lac Kariba, le plus grand lac intérieur créé par l'homme, à un moment où les impacts environnementaux et sociaux de ce type de développement étaient alors inconnus, a révélé des impacts multiples. La réserve de biosphère détient un record exceptionnel d'impacts autant humains qu'environnementaux dans le cadre des projets de grands barrages.

En dehors des menaces à la biodiversité exercées par le réchauffement planétaire en Afrique australe, la pression humaine sur les ressources naturelles devient aussi une menace grandissante pour la biodiversité dans la région. Dans la vallée du Zambèze, la chasse illégale de produits de la faune comme la corne de rhinocéros et les défenses d'éléphants, a démontré que les espèces peuvent être amenées à la limite de l'extinction en un laps de temps. Des expériences utiles dans les stratégies de gestion pour faire face à cette menace dans la réserve de biosphère du Moyen Zambèze peuvent contribuer à cette menace globale à la diversité. Ces stratégies ont consisté, d'une part, en une détermination résolue de lutter contre le crime ainsi que la création d'un environnement permettant aux communautés locales de réaliser la valeur économique de la biodiversité. La valeur de la réserve de biosphère du Moyen Zambèze dans son ensemble, pour le développement économique est discutée brièvement. La réserve de biosphère du Moyen Zambèze incorpore également les sites du patrimoine mondial de Mana Pools et de Chewore.

Mots-clés: Réserve de biosphère du Moyen Zambèze; Ecorégion 54 des boisés zambéziens et de Mopane; Patrimoine mondial; impacts des changements climatiques; Lac Kariba; relocalisation involontaire; désinsectisation; menaces à la biodiversité; interactions homme-faune



Figure 1a: Map of the Middle Zambezi Biosphere Reserve area showing topography and core areas (black lines)

(From: Middle Zambezi Biosphere Reserve Nomination)

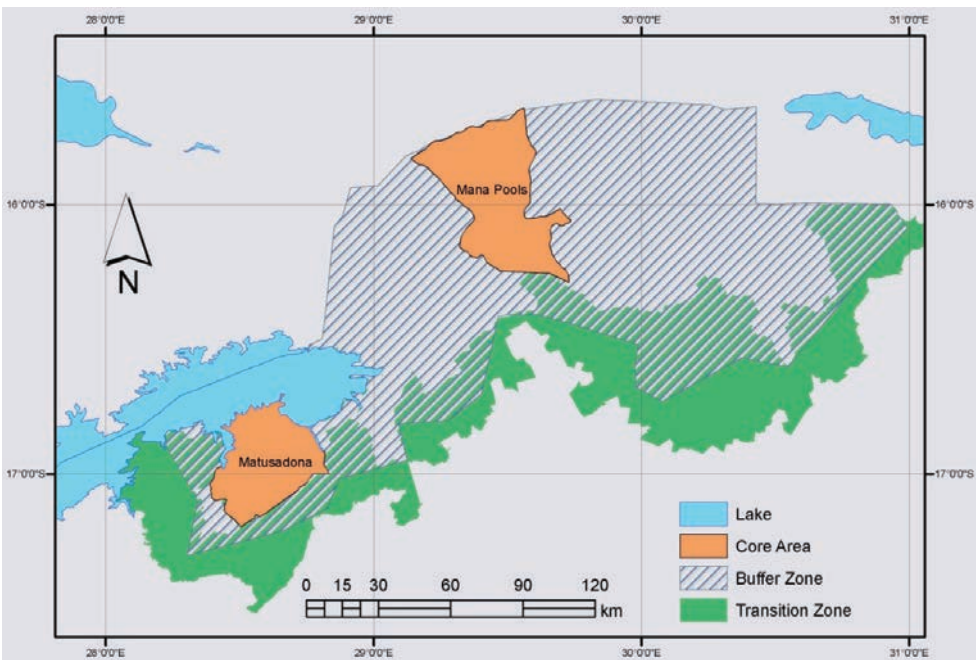


Figure 1b: Zonation map of the Middle Zambezi Biosphere Reserve

(From: Middle Zambezi Biosphere Reserve Nomination)

1. Introduction

On June 5th 2010, UNESCO listed the Middle Zambezi Biosphere Reserve as a member of the global Biosphere Reserve family. The Middle Zambezi Biosphere Reserve (MZBR) is Zimbabwe's only biosphere reserve and also the only one in the Zambezi River basin. In addition, the Basin has several wildlife conservation areas in Zambia, Malawi, Botswana and Namibia. All of these were established before the middle of the last century, when human populations and land pressure in the basin were low. Thus, as human populations have more than trebled, the "hard edge effect" at the interface of wildlife areas and communality settlements has become more intense, in some cases to the detriment of the natural resources in the conservation areas. It is with these considerations that the Zimbabwe National Man and Biosphere Committee resolved to establish a biosphere reserve, in conjunction with the existing conservation areas of the Middle Zambezi valley. The accession by Zimbabwe to the UNESCO Biosphere Reserve programme offers the country opportunities in natural resource conservation programmes as well as cooperation in research with other established biosphere reserves in the world. It also offers the opportunity of reconciling development with conservation. Up to now, Zimbabwe has operated on the classical mode of National Parks estates, which exclude participation of local communities, resulting in ever-escalating conflict between communities and wildlife.

2. The area

The Middle Zambezi Biosphere Reserve (28°E: 30°E; 15:30S: 17:20S) lies in the Zambezi valley, covering some 21 616 km², at an elevation of around 300 to 400 m above sea level (Figure 1a). Zonation of the biosphere reserve covers core areas, a buffer zone and a transition zone (Figure 1b). Of the total area of the biosphere reserve, 83% of it comprises the core and buffer zones. The MZBR is located in the western extension of the East African Rift Valley's southern end. The MZBR stretches from the mouth of the Sengwa River to Kanyemba, including all the wildlife management areas of the valley, as well as the CAMPFIRE (Communal Areas Management Programme for Indigenous Resources) project areas in adjacent communal areas. Its orography gives it a unique climatology, rendering it a natural laboratory for climate change studies. It consists of a valley floor, close to 1000 m below the Zimbabwean plateaux and steep escarpment on the northern and southern edges of the valley.

Table 1: Summary of temperatures in the decades 1969–1979 and 1990–2000

Period	1969 to 1979				1990 to 2000			
Season	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
Maximum Temperatures								
Mean max	30.8	29.6	26.9	33.9	32.3	31.4	28.2	35.1
S.D	1.0	1.2	0.4	0.6	1.0	0.8	0.4	0.7

Period	1969 to 1979				1990 to 2000			
Season	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
Minimum Temperatures								
Mean min	21.6	17.7	11.8	21.8	22.4	18.6	13.1	22.5
S.D	0.6	0.4	0.9	0.7	0.6	1.0	0.7	0.6

The summary of temperatures in Table 1, taken from the Kariba station, show that there has been an increase of just over 1°C between the late 1960s and the end of the last century. This has brought changes in the aquatic ecosystem of Lake Kariba, notably the dominance of blue-green algae that prefer temperatures above 28°C. This fundamental shift in the phytoplankton community has affected the zooplankton community and the pelagic fishery dependent on it (Magadza 2011).



Figure 2: Lioness guarding a kill (left); hairless albino baboon (right)

3. Biodiversity

The Zambezi valley as a whole is one of the very important biodiversity centres of the subregion, termed Region 54, the *Zambezi and Mopane Woodlands* (Burgess *et al.* 2004). Figures 2 and 3 show some of the sights in the MZBR. It is described as Tropical and Subtropical Grasslands, Savannas, Scrublands and Woodlands. It ranks among the top ten ecoregions with respect to vertebrate biodiversity with a total of 960 species. With respect to the Richness and Endemism Index, the ecoregion scores “Regionally Outstanding” (Burgess *et al.* 2004). In general, the vegetation of the valley is more nutritious than that of the surrounding Miombo biome, hence the valley supports large numbers of mammals.

This biodiversity is increasingly becoming a significant development asset, with tourism bringing in hundreds of millions of dollar income annually to the riparian states. In the earlier decades in the Zambezi basin, local communities watched over the fence as privileged visitors enjoyed the benefits of the basin’s biodiversity. However, as the Community Based Resource Management concept evolved, local communities are increasingly becoming custodians of their natural resources, rather the state monopoly.

However, the low level of awareness and limited negotiating capacity greatly reduces the level of benefit the communities enjoy.



Figure 3: Elephant dung with plastic bin bags, Kariba. Some elephant bulls have taken residence in town to escape the hunters.

The MZBR can boast a fair share of the region's biodiversity. In addition the inclusion of the Sanyati Basin of Lake Kariba, the largest man-made lake in the world, adds an industrial aspect to the aquatic resources normally found in the large lakes such as Lake Victoria between Tanzania, Uganda and Kenya. A visitor seeing Lake Kariba at night might think the lights of night-fishing boats, fishing the introduced Lake Tanganyika sardine (*Limnothrissa miodon*), represents settlements. This fishery, together with the now cage-culture produced Nile tilapia (*Oriochromis niloticus*), not only provides much needed protein, but together with ancillary support services, provides employment to an area that has limited resources for livelihoods.

In the terrestrial environment the valley is dominated by the Mopane tree (*Colophospermum mopane*) and *Combretaceae* species, while the escarpment is dominated by *Terminalia/Commiphora* complex, merging into *Brachystegia* dominated woodland on the plateaux edge (Burgess *et al.* 2004).

There are over twenty mammalian species, including the big species like elephant, buffalo, kudu, impala, water-buck, zebra, hyena, and, on the escarpment, sable. Threatened species, such as the painted dog (*Lycaon pictus*), occur in sustainable populations, while the once icon of the valley, the black rhino (*Diceros bicornis*), has virtually been poached to extinction in the valley.

Bird species abound in the valley, including some endemics, Meves's starling (*Lamprotornis mevesii*), Shelly's sunbird



Figure 4: Nesting site of Southern Carmine Bee-eaters near Rifa education camp, Chirundu

(*Cinnyris shelleyi*), Lilian's Lovebird (*Agapornis lilianae*) and the near-endemic White-bellied Sunbird (*Cinnyris talatala*).

Many bird species require special breeding sites. An example in the MZBR is the Southern Carmine Bee-eater (*Merops nubicoides*), which breeds on riverbank cliffs. Figure 4 shows a Southern Bee-eater colony nesting site, with each hole representing a breeding pair. This site is the eroding cliff face in what was once a river meander, probably several hundreds of years ago. Thus unlike other bird nests which are constructed each time the birds are in breeding season, these nesting sites are a fixed asset to this species and once lost to development they cannot be replaced, or at least not in a season. Other birds, such as the African Skimmer (*Rhynchops flavirostris*), roost and breed on instream sand banks. A sudden change in river flow when the power stations at Kariba release large amounts of water when the floodgates are opened, destroys such instream habitats. This can affect a significant number of animal species.

4. Issues of sustainable development

The creation of Lake Kariba and the establishment of the wildlife management area in the Zambezi valley resulted in the displacement of peoples who lived in the valley; people who had evolved an economy based on the rhythm of the Zambezi River; an economy that was isolated from the merging western monetary economy that was imported onto the plateau peoples over a century ago. The most widely documented case is that of the Tonga people (Scudder 1991, 1993). Unlike the people from the Mana Pools area who were moved to the Urungwe area in which sustainable agriculture is possible, the Tonga were moved onto marginal lands, the management of which they had no experience. Consequently, the Tonga communities remain the most impoverished food-deficit community of Zimbabwe. While the wildlife-based tourist and safari industry brings in millions of dollars, the revenue goes to the state and little of it returns for the development of the valley people. The only benefit the valley people earn from the natural resources is the revenue from the CAMPFIRE programme, but the bureaucratic chain this revenue has to flow through, results in insignificant benefits at household level.

There is a misguided short-sighted view driven at the political platform: that of maximising cash inflow from the environment-based tourism industry. One senior political potentate in Zimbabwe has been quoted "a few frogs cannot stop a multimillion development project", referring to the construction of a hotel complex on a prime wetland. In the MZBR, sinister threats to the integrity of the biosphere



Figure 5: Large haulage transporter after delivery of construction material at an exclusive compound. Vehicles in this wilderness area would normally be restricted to family cars or six-seater tourist game-viewing vehicles.

reserve have recently emerged. The Mana Pools World Heritage status was based, among other qualities, on the “exceptional wilderness” quality of the area, particularly the flood plain along the Zambezi River. In a bid to raise income, the Zimbabwe management authority of the parks and wildlife estate has granted development rights for exclusive visitor accommodation along the riverfront. The construction of these accommodation units involves gross alteration (including vegetation destruction, incompatible buildings, waste management) of the wilderness qualities. An even more sinister development is the floated intent to prospect for sand minerals (rare heavy metals) in the rivers of the wilderness area. This would involve vegetation and top soil stripping on at least three river courses and their riparian environs, and transportation of large amounts of ore-bearing sand to a processing plant, probably on the Zambezi River (Figure 5). To recover the ore, the operation would need to scoop sand from a depth of 5–16 m. This essentially would destroy the Mana Pools wildlife reserve.

5. Fire

For close to thirty years the Makonde/Kariba districts of the Zambezi valley was sprayed for tsetse fly (*Glossina morsitans*). For safety from surprise attacks by wild animals, the operation areas were pre-burned before the spray team moved in. Although ground spraying has now been replaced with ecologically benign odour baited traps, the pyromania persists, and now with increased frequency. This is changing the vegetation structure of the reserve, especially in the *Brachystegia* biome, where canopy woodland is converted to regenerating bush with an increase of grass to woodland cover. Figure 6 shows an elephant making a meal from burnt vegetation.



Figure 6: Elephant searching for browsing after fire, Kariba

6. Unplanned development

The Middle Zambezi valley climate has not attracted the natural evolution of urban settlements. However, the creation of a service facility, such as power generation at Kariba, or border post services at Chirundu, necessitates the posting of core staff to operate these services. Invariably the lack of amenities at such outposts results in the staff leaving their families behind. Consequently, other service providers, such as groceries and motor vehicle service amenities, settle at the outpost. With no urban management structures, the growth of these settlements is unregulated, leading sometimes to informal settlements with inadequate water and sanitation facilities. It took Kariba

more than twenty years to introduce planned settlement structures and services. Figure 7 shows the current situation at the Chirundu border post. Here truckers spend a minimum of three days with no public amenities. The settlement itself largely consists of unauthorised dwelling structures (Figure 8). The long queuing time for border services has now resulted in some trucking companies clearing parking lots for their vehicles in areas that affect movement of wildlife to watering points.



Figure 7: A long queue of long distance heavy trucks awaiting border clearance at Chirundu



Figure 8: Informal settlement with no water and sanitation facilities at Chirundu

7. Pest management

The Middle Zambezi is home to a number of pests. Notable among these are the tsetse fly (*Glossina morsitans*) and malaria transmitting mosquitoes of *Aedes* and *Anopheles* species. The tsetse fly transmits schistosomiasis to humans and livestock. To enable resettlement of the Tonga displaced by the creation of Lake Kariba, there has been a protracted control programme for these pests. Originally both vectors were controlled by pesticide spraying, particularly DDT. This pesticide became pervasive in the ecosystem, and affected a wide spectrum of organisms (Magadza 2010). However the ground application of DDT is no longer necessary due to the development of ecologically benign odour baited traps (Torr *et al.* 1997) that, when combined with residual chemosterilant on the traps, can eradicate the fly from the environment (Figure 9).



Figure 9: Odour baited trap for sterilisation of male tsetse flies

8. Education

The greatest challenge of the MZBR is to make the valley inhabitants aware of the richness of the valley's natural biodiversity resources, and that they can benefit from it. The author once witnessed a group of children at Nyamhunga Township chasing an elephant with dogs. Fortunately elephants in Kariba can tell the difference between harmless children and grown-ups!

Three institutions are currently addressing this problem:

- The University of Zimbabwe Lake Kariba Research station with its schools outreach programmes and post-graduate research;
- The Zimbabwe Hunters' Association with their well provided Rifa Education Camp near Chirundu. Figure 10 shows a group of Master students of the University of Zimbabwe on a wildlife ecology field trip based at Rifa; and
- The Wildlife and Environment Society of Zombabwe (WEZ).



Figure 10: Wildlife ecology class on field trip at Rifa education camp, Chirundu

9. Prospects

The newly established Middle Zambezi Biosphere Reserve's priorities include:

- Identifying means of family-based income generation.
- Investigating opportunities offered by the vast forest resources in the carbon market.
- Creating institutions for community-based natural resource management.
- Creating an environment conducive to education and skills development, to enhance the competitive strength of employable men and women on the labour market.
- Resolution of human/wildlife conflicts for the harmonious co-existence of communities with their natural resources.

These objectives require vision and sustained effort on the part of the management of the Middle Zambezi Biosphere Reserve.

10. Challenges

The obvious challenge in managing such a large biosphere reserve is funding. So far the management committee has no secure source of funding, but is finalising strategies to address this issue. This includes:

- Establishing partnerships with enterprises operating in the valley.
- Using state facilities to raise funds from the Global Environment Facility.
- Establishing partnerships for the carbon trade market.
- Encouraging entrepreneurship among the reserve inhabitants to develop commercial activities based on sustained use of the biodiversity resources.

These are mammoth tasks that indeed require financial and management muscle, as well as innovative thinking.

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Advocating for the Improvement of Biodiversity Conservation in the Bia Biosphere Reserve through Community and Institutional Empowerment

Préconiser l'amélioration de la conservation de la biodiversité dans la Réserve de biosphère de Bia par l'autonomisation de la communauté et des institutions

ANTWI-BOASIAKO AMOAH¹

Abstract

The role of civil society in protecting and managing the environment is of high importance especially in areas and economies where clearly defined and well functioned structures for decentralization exist. Evidence abounds in research and also in projects, especially in the advanced countries, where civil society organizations have played active roles in the protection and management of the environment. This has happened in states where structures and systems have been designed to empower the people to be part of the system and to take their own initiatives in diverse issues including their own environment.

The sustainability of the Bia Biosphere Reserve in Ghana could be enhanced if communities were to be empowered and sensitized with regards to their responsibility and the benefits thereof of engaging in conservation practices.

In a break from the previous path of development which considered communities to hinder progressive social change, this paper champions the role of community in bringing about decentralization, meaningful participation and cultural autonomy in forest conservation.

Despite its recent popularity, the concept of community rarely receives the attention from those concerned with resource use and management.

The focus of this paper is on community groupings and associations as well as environmental non-governmental organizations in the Bia district. The issue of how to

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empower these groups to play a central role in the conservation and protection of the forest resources in their locality is strongly emphasized.

Key Words: empowerment, community conservation, sustainability, decentralization, biosphere reserve

Résumé

Le rôle de la société civile dans la protection et la gestion de l'environnement est d'importance cruciale notamment dans les zones et les économies où des structures clairement définies et au bon fonctionnement pour la décentralisation existent. Les preuves abondent en termes de recherche et également dans les projets, surtout dans les pays industrialisés où les organisations de la société civile ont joué des rôles actifs dans la protection et la gestion de l'environnement. Ce fait est constaté dans les Etats où des structures et des systèmes ont été conçus pour autonomiser les citoyens en les faisant participer au système et pour les laisser prendre leurs propres initiatives dans diverses questions y compris leur propre environnement.

La durabilité de la Réserve de biosphère de Bia au Ghana pourrait être améliorée si les communautés étaient habilitées et sensibilisées eu égard à leur responsabilité et aux avantages découlant d'un engagement dans les pratiques de conservation.

Rompant avec la vision précédente du développement qui considérait que les communautés faisaient obstacle au changement social progressif, ce document défend le rôle de la communauté dans la mise en place de la décentralisation, la participation significative et l'autonomie culturelle en matière de préservation de la forêt.

Malgré sa popularité récente, le concept de communauté reçoit rarement l'attention de ceux concernés par l'utilisation et la gestion des ressources.

Ce document se concentre sur les groupements et associations communautaires ainsi que sur les organisations non gouvernementales dans la région de Bia. La question de savoir comment habiliter ces groupes à jouer un rôle central dans la conservation et la protection des ressources forestières dans leur localité est mise en exergue.

Mots-clés: autonomisation, conservation communautaire, durabilité, décentralisation, réserve de biosphère

1. Introduction

The Ghana Forest and Wildlife Policy of 1994 enshrines the principle of conservation through sustainable development and clearly states the Government's intentions with regard to the wildlife resource and protected area management. The policy explicitly recognises the need to associate local communities with protected area management through the generation of benefits such as natural resource utilisation and employment (Bia Conservation Area 2001).

In the past, the wildlife division has pursued a traditionally preservationist attitude towards protected areas though it has rarely had the resources for appropriate

enforcement. This approach has alienated local communities and has excluded opportunities for participatory rural development activities and the sustainable use of the reserves' resources. At the same time it has discouraged the involvement of private enterprise in the utilisation of the wildlife resource and protected areas and failed to recognise the importance of wildlife within the managed economy. As a result reserves have all too often been subject to unsustainable exploitation of their natural resources. This situation is not unique to Ghana, it is also apparent in many developed and developing countries.

The future integrity of Bia Biosphere Reserve relies on both developing a system through which all players can interact, and a programme of intervention involving resource input, training and education. This will enable and empower stakeholders to regulate their resource use efficiently.

2. Bia at a glance

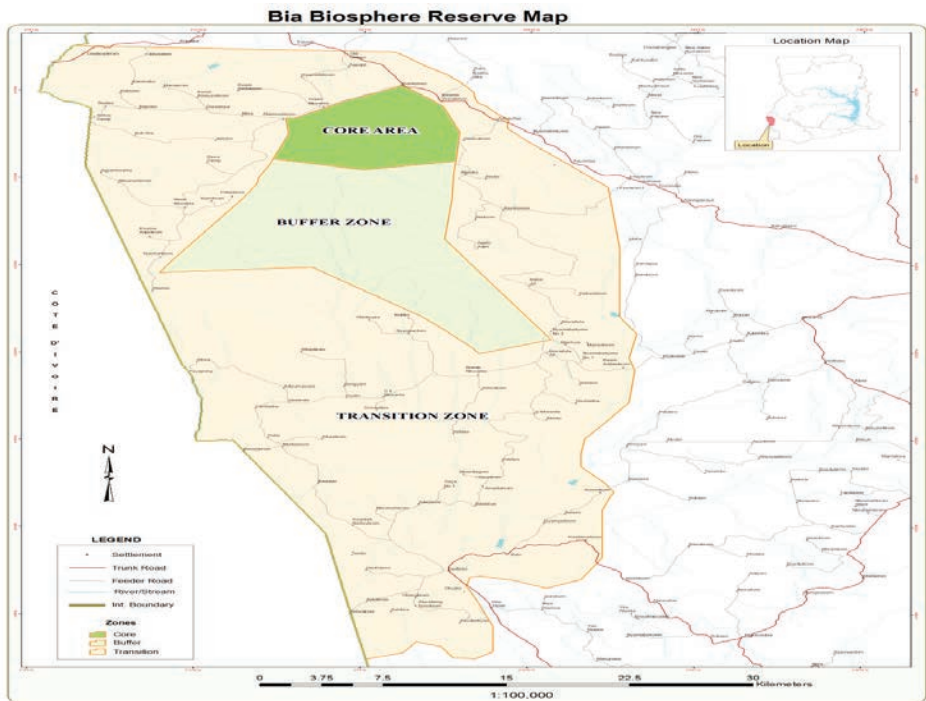


Figure 1: Zoning of Bia Biosphere Reserve

Bia National Park was designated a Man and Biosphere (MAB) Reserve in 1983, the only such reserve so designated in Ghana. At the moment, the area had been the subject of years of scientific studies and more is known about this reserve than any other wildlife area in the high forest zone.

The off-reserve areas around Bia are under several layers of administration, tenure and management systems. There are a number of governmental institutions that have varying impact and authority on land use. This is a very complex situation that needs to be understood to place Bia in its regional context in order that threats to conservation and opportunities for biosphere management can be identified and solutions proposed. The map in Figure 1 gives the location and zoning status of the Bia Biosphere Reserve.

The situation of transition and buffer zones around Bia is typical of many rural areas in Ghana. The majority of the people are farmers; however, they are also heavily dependent upon natural resources to meet their basic daily needs. Importantly, bushmeat forms a large part of their animal protein intake. Communities have poor access to health, education and basic infrastructural needs such as roads, water and sanitation. Access to markets for conventional crops is poor. As a result the farmers suffer marketing problems. This, combined with the perverse pricing of cocoa, encourages the cultivation of this crop in preference to all others and in mono-culture leading to the degradation of the environment.

3. Motivation and objective of the study

Biosphere reserves are established to protect and develop large-scale and traditionally variously used natural and agricultural landscapes, including the diversity of biotopes and species that historically originated there. At the same time, they serve as models for the development and testing of ecologically compatible forms of sustainable land use. Sustainable use by humans is expressly part of the biosphere reserve concept. Sustainable use refers to management techniques that are lastingly and environmentally sound and compatible with nature in a comprehensive sense.

Implementation of this concept requires that all those involved in it (in particular policymakers, administrations, associations and inhabitants) have as broad as possible agreement on the objectives and measures in the sense of how the area could be governed effectively. Effective governance, in this context, is the process of collectively making and implementing decisions regarding the reserve and other protected areas.

In the past in Ghana, different institutions and individuals have tried different piecemeal approaches to protect and manage reserves and protected areas, but the results have not been encouraging. This might be due to the fact that effective, systematic, comprehensive and sustainable approaches or methods of delivery were not employed.

This paper advocates for a paradigm shift in managing and protecting biosphere reserves where individuals and communities live “far away” from their own environment. Individuals, communities and civil society organizations should be empowered to be major partners in biosphere reserve protection in Ghana.

The main objective of the paper is to advocate or spearhead a campaign where institutions, communities and individuals will be encouraged to take urgent action(s) to conserve and to protect the environment and to raise the levels of education and advocacy to better “our world” which is rich in natural resources, to preserve it for future generations and to protect ourselves from all forms of environmental harms. In the end,

this will enable people to take their own initiatives to overcome their environmental problems and also to improve their living standards.

The essence is to share knowledge and information with members of the AfriMAB network on the role of empowerment in ensuring effective natural resource management in Ghana.

The paper is developed with the following thought questions in mind:

- What does empowerment mean in biosphere reserve protection and management?
- How have local communities been empowered to protect the rich biodiversity which the country is endowed with?
- Which instruments are available for the empowerment of the people in the protection and management of biodiversity in the country?

4. Methods/procedures

This paper is not an outcome of field studies in the Bia area. It is an advocacy piece on community involvement in biosphere reserve development and management in Ghana. It is a desk top study in which the author reviewed management plans, strategic policy documents and other articles and papers on the subject matter. The paper defines and analyzes empowerment in the context of natural resource and environmental protection and management with special emphasis on the Bia Biosphere area.

The paper concludes with some key recommendations on how the government of Ghana and the other state institutions responsible for the Bia Biosphere Reserve and other national parks could empower the local community and other local actors such as civil society organizations to play active roles in natural resource conservation in the area.

5. Empowerment: what is it?

Empowerment is a word that is often seen as ambiguous or indefinable and therefore must be used cautiously (Thomas & Velthouse 1990). It has been used differently depending to which context or situation one is applying it. For instance the concept has been advocated for and applied widely in the legal field where “helpless” individuals and groups have been empowered through comprehensive programmes and policies to be informed and made aware of their rights and responsibilities.

Legal empowerment in natural resource protection, according to the International Institute for Environment and Development (IIED) requires addressing constraints through actions at different levels, including for instance:

- law reform to establish or improve legal arrangements that strengthen the protection of local resource rights, or that provide greater say in decision-making processes affecting these rights;
- strategies, approaches and support materials to help local groups make the most of the opportunities offered by the law, including legal literacy training, legal assistance,

individual and public interest litigation, and representation and advocacy (www.iied.org/resources).

Empowerment, therefore, is the process through which someone who feels unable to change something in their life is supported in finding ways of doing so. Through empowerment one can move from a position of 'helplessness' to a state of being able to create a new way forward with a particular difficulty that he or she is experiencing.

In other words, it is a process which enables individuals or groups to fully access personal or collective power, authority and influence, and to employ that strength when engaging with other people, institutions or society.

Therefore, in the wake of unsustainable utilization of natural resources in Ghana, climate change and its impacts on vulnerable communities and sectors in the country, inefficient use of energy and water in households, etc., how do we empower the people who are at the center of these issues to take active part in dealing with those issues?

6. Defining community empowerment

How is community empowerment in natural resource management and protection defined and who defines it? It is simplistic to speak of "community" even in a single settlement; villages can be sharply divided socially, economically, and politically when there are competing interest groups. Many members — particularly women and minorities — may not participate in decision-making. Indeed, sometimes people find the very idea of acting as a community alien in societies and settlements where conservation has been traditionally carried out by individual households, kin groups or neighbourhoods (Furze *et al.* 1996, Deneulin & Shahani 2009).

The Forest and Wildlife Policy of 1994 recognises the need to associate local communities with protected area management. The policy also establishes the principle for the partial retention of locally raised revenue both for expenditure within protected areas and for disbursement to the local community.

The policy goes on to say that developing Community Resource Management Areas (CREMA) coupled with the recommended infrastructural and institutional strengthening on-reserve will be the best hope of ensuring the future integrity of the Bia rainforest and, indeed, the conservation of the Protected Areas System of Ghana. There is however a major difference between having these initiatives on paper and having the political will and financial capabilities to implement them. There have been several structures created at the local level such as Area Committees and Unit Committees as part of government's decentralisation process. Area Committees



Figure 2: Stakeholder Engagement in the Bia Biosphere Area

and Unit Committees were established in 1998 to provide communities with administrative representation with the intention of stimulating grassroots participation in the political process (Figure 2). Most of these structures at the local levels exist as mere entities without the necessary autonomy and capacity to function properly as expected. The creation of the CREMAs in the Bia Biosphere Area is actually a good platform to upscale, replicate and sustain community involvement in natural resources management.

According to the Bia Conservation Area Management Plan of 2001, the Bia Conservation Area is entirely located within the administrative district of the Juabeso-Bia District Assembly (Bia Conservation Area 2001). This Assembly has a fairly active environmental sub-committee. However this committee is not performing well due to lack of funds rather than apathy on the part of the members. The issue of whether communities really exist and whether the people within them have shared interests and consensual decision-making processes in the Bia Area is of prime research interest.

7. Empowerment and natural resource protection

Poor conservation outcomes that followed decades of intrusive resource management strategies and planned development have forced policy makers and scholars to reconsider the role of the community in resource use and conservation. In a break from previous work on development which considered communities to hinder progressive social change, current writing champions the role of community in bringing about decentralization, meaningful participation, cultural autonomy, and conservation (Argawal 2010, Chambers & McBeth 1992, Chitere 1994, Etzioni 1996). Despite its recent popularity, the concept of community involvement rarely receives the attention or analysis it needs from those concerned with resource use and management.

In developing economies, a large percentage of the population depends on forest resources and other natural resources for their livelihoods and Ghana is no exception. These resources have, however, over the recent years been depleted at an alarming rate, faster than they could regenerate.

Although a wide range of policies to conserve the environment in the forest zones in Ghana exists on paper, in practice most are only applied in the commercially-valuable timber reserves. Environmental policies have little impact on those living in the forest margins since they are only sporadically applied, and even accepted community norms for resource use tend to be set aside when their application would interfere with key occupations (Parmar 2003). Livelihoods, however, depend heavily on natural resources, so conservation is necessary. The dilemma is to devise policies that are effective. Empowering the local communities and civil society groups in these processes is very important. The following questions arise:

- How do we engage the people whose livelihoods depend largely on these resources in the policy formulation and implementation processes?
- Which role can they also play given the needed support and direction?

7.1 How do we empower the local communities and other institutions in biosphere reserve conservation and management in Ghana?

Biosphere reserve conservation and management is a multi-stakeholder business. The actors involved are many as the issues involved are diverse. Bringing all the relevant stakeholders on board in the empowerment process is a key step. Though there are formal institutions such as the Wildlife Division of the Forestry Commission, the Environmental Protection Agency (EPA) and other institutions mandated to manage and protect the country's biosphere resources, the role of community groupings and civil society organizations as well as the private sector is very key. This means both top-down and bottom-up approaches are necessary.

Quite often the former approach had been employed at the expense of the latter. So the first task in the empowerment process is to identify which individuals, groups and institutions needed to be empowered to protect and manage the biosphere reserves. This will help project and programme implementers to apply the appropriate empowerment tools and techniques. The focus of this contribution is community groupings and associations as well as environmental non-governmental organizations in the Bia Reserve area and other reserves in the country.

7.2 How do we then empower these groups to play a central role in environmental protection and resource management in the area?

Various methods (depending on the needs of a particular group) such as formal and non-formal education, capacity programmes, creation and management of sustainable community environment clubs etc., could be employed.

When a project or programme is being planned to empower the people in environmental issues, the following thought questions could be of relevance:

- Which are the key environment and resource problems or issues?
- How do these problems/issues affect the livelihoods and health of the people as well as the other ecosystems in the short or long run? (Environment-Livelihood Analysis).
- What role can such groups and individuals play in dealing or handling those issues at hand?
- What benefits could their interventions or actions bring to themselves and the environment?
- What are the main needs of these groups or institutions with regards to environmental protection and management?
- What strategy will be appropriate in empowering them on environmental issues?

Empowerment, according to Blanchard and others (1996), should be carefully thought through to ensure effective results.

8. Conclusion and recommendations

In conclusion, advocating for the empowering of people and institutions in environmental management and protection is innovative and therefore projects and programmes to empower the local people in the Bia area should be those that:

- will provide individuals, communities and other institutions in the BIA Biosphere Reserve area the ability to make decisions about personal or collective circumstances in environmental protection and management;
- will provide individuals, communities and other institutions in the area the ability to access information and resources on the environment for decision-making;
- will provide the people with the ability to consider a range of options regarding their environment from which to choose, thus not just yes/no, either/or to decisions from government authorities on the environment;
- will help them to exercise assertiveness in collective decision making regarding the conservation and management of the reserve;
- will make the local community think positively about the ability to make change and make the reserves better for future generations;
- will provide individuals the ability to inform others' perceptions on the environment through exchange, education and engagement;
- will assist individuals and communities in the Bia Biosphere Reserve area to take initiative regarding what needs to be done to preserve this traditional heritage.

The future integrity of the Bia Protected Area relies on both developing a system through which all relevant players can interact and a programme of intervention involving resource input, training and education. This will enable and empower stakeholders to regulate their resource use efficiently.

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Ethnozoology Applied to the Mare aux Hippopotames Biosphere Reserve in the South-Sudanese Zone of Burkina Faso

Ethnozoologie appliquée à la Réserve de Biosphère de la Mare aux Hippopotames en zone sud soudanienne du Burkina Faso

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Abstract

Ethnozoology applied to the Mare aux Hippopotames Biosphere Reserve (RBMH — Réserve de Biosphère de la Mare aux Hippopotames) aimed to survey the indigenous knowledge of riparian inhabitants about the reserve and wild fauna. The study was conducted as a survey and inventory of economic activities, knowledge of wild fauna and the importance of the reserve for the population.

The surveys were conducted in six riparian villages and generated an inventory of 11 economic activities, of which the most important are agriculture, stock farming, reserve monitoring/patrolling and fishing, practised by 100%, 32%, 14% and 8% of the riparian population, respectively. The reserve hosts 37 species of wild fauna, several of which have disappeared (red-flanked duiker, hartebeest, buffalo, lion and leopard). According to 88% of the population, human-wildlife conflicts are frequent due to crop damage by monkeys, hippopotami and elephants, cited by 34.6%, 29.6% and 13.6% of the surveyed individuals, respectively. Despite this damage, the population recognizes the importance of wild fauna in their culture, as four of the species are used in traditional medicine and to invoke spirits.

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The reserve and the water body also play an important socio-cultural role in the riparian populations. According to 91% of these populations, the reserve is a precious asset which improves vegetation diversity and wild fauna. The reserve provides employment through the development of tourist guides, forest monitoring/ patrolling, commercial fishing and the harvesting of dead wood.

Key words: Indigenous knowledge, wild fauna, vegetation diversity, poaching, cultural identity.

Résumé

L'ethnozoologie appliquée à la Réserve de Biosphère de la Mare aux Hippopotames (RBMH) a visé à recenser les connaissances endogènes des populations riveraines sur la RBMH et la faune sauvage. L'étude s'est déroulée sous forme d'enquêtes et a porté sur l'inventaire des activités économiques, la connaissance de la faune sauvage et l'importance de la réserve pour la population.

Les enquêtes conduites dans six villages riverains ont permis d'inventorier 11 activités économiques dont les plus importantes sont l'agriculture, l'élevage, la surveillance de la réserve et la pêche pratiquées respectivement par 100 %, 32%, 14% et 8% de la population riveraine de la réserve. Cette réserve renfermait 37 espèces de faune sauvage mais quelquesunes d'elles (le céphalophe à flanc roux, le bubale, le buffle, le lion et la panthère) ont disparu. Selon 88% de la population, les conflits faune sauvage-hommes seraient fréquents suite aux dégâts sur des cultures dans les champs occasionnés par les singes, les hippopotames et les éléphants cités respectivement par 34,6 %, 29,6 % et 13,6% des enquêtés. Malgré ces dégâts, la population reconnaît l'importance de la faune sauvage pour leur société dont quatre des espèces citées sont utilisées en médecine traditionnelle et pour l'obtention de forces occultes.

De même la réserve et la mare jouent un rôle socioculturel important pour les populations riveraines. Selon 91% de ces populations, la réserve constitue un bien précieux avec l'amélioration de la diversité végétale et de la faune sauvage. Elle leur procure des emplois avec le développement des guides touristiques, des surveillants de forêts, de la pêche commerciale, de l'exploitation des bois morts et autres.

Mots clés: Connaissances endogènes, faune sauvage, diversité végétale, braconnage, Identité culturelle.

1. Introduction

Ethnozoology is by definition the study of the zoological knowledge of different ethnic groups and their relationship with animal species (Chevallier *et al.* 1988). According to these authors, the term was first used in 1914 by the anthropologists Henderson and Harrington who were studying Indian tribes in the Prairies. The discipline did not established itself as such until 1963 through the founding of the Ethnobotany Laboratory

with the development of a section dedicated to ethnozoology in the French National Museum of Natural History (*Muséum National d'Histoire Naturelle de la France*).

In Africa, animals are of considerable importance to societies. In some cultures, each family has a totem or taboo animal linked to them which was chosen as a common ancestor from a specific animal species. Considering the numerous uses of wild fauna in the everyday life of African populations, it seems even more evident that conservation and maintaining certain fauna population levels is necessary for their social and cultural identity (Chardonnet 1995, Czudek 2001). In African cultures, respect, worship and a humane attitude towards wild animals find their essence in the belief in the interference of supernatural forces between human society and the animals of the forest (Kabré 1996). Doucet (2003) reveals that for Gabon's Mahongwe people, the animal world plays a dominant role in the expression of moral cultural values, which is evident in the numerous references to animal species in most nouns related to family, and especially in the particularly high number of proverbs referencing animal species.

To this effect, ethnozoology has pride of place in the sustainable management process of classified forests (Yaokokoré-Béibro 1995), which is the reason for the research hypothesis of this work: "taking indigenous knowledge into account contributes to the sustainable management of wild fauna in protected areas".

The aim is to make an inventory of indigenous knowledge about the biosphere reserve and wild fauna.

2. Methodology

2.1 Study setting

The current Mare aux Hippopotames Biosphere Reserve (*RBMH — Réserve de Biosphère de la Mare aux Hippopotames*) was previously a classified forest according to Decree no. 8336 SE of 26 March 1937 and was integrated in the biosphere reserve network on 12 January 1987 by UNESCO (Chardonnet 1995, Taïta 1997). The reserve has a tapered shape, as it is 26 km in length and between 4 and 9 km in width. It covers an area of approximately 19 200 ha and is situated roughly 60 km north of Bobo Dioulasso. It lies between latitude 11°30' and 11°45' north and longitude 04°05' and 04°12' west (Figure 1).

The reserve's climate is of a Sudanese type, with annual precipitations of 1 100 mm spread over 4 to 6 months, from May to October (Bélem 2008). Its vegetation consists of several formations including aquatic vegetation surrounding the water body, gallery forests, woodlands, dry dense forests as well as wooded and shrubby savannah types (Taïta 1997, Bélem 2008).

The wild fauna in this reserve is famous for its hippopotami (*Hippopotamus amphibius* L.) that permanently inhabit the area and have given the site its name: Mare aux Hippopotames Biosphere Reserve. According to recent studies, the population numbers of this species have increased from 33 individuals, recorded in June 2006, to 42 individuals in June 2008, as a result of the riparian village populations' monitoring activities in collaboration with agents from the Ministry of Environment (Dibloni *et al.* 2010). Other mammals such as elephant (*Loxodonta africana* Cuvier), bushbuck

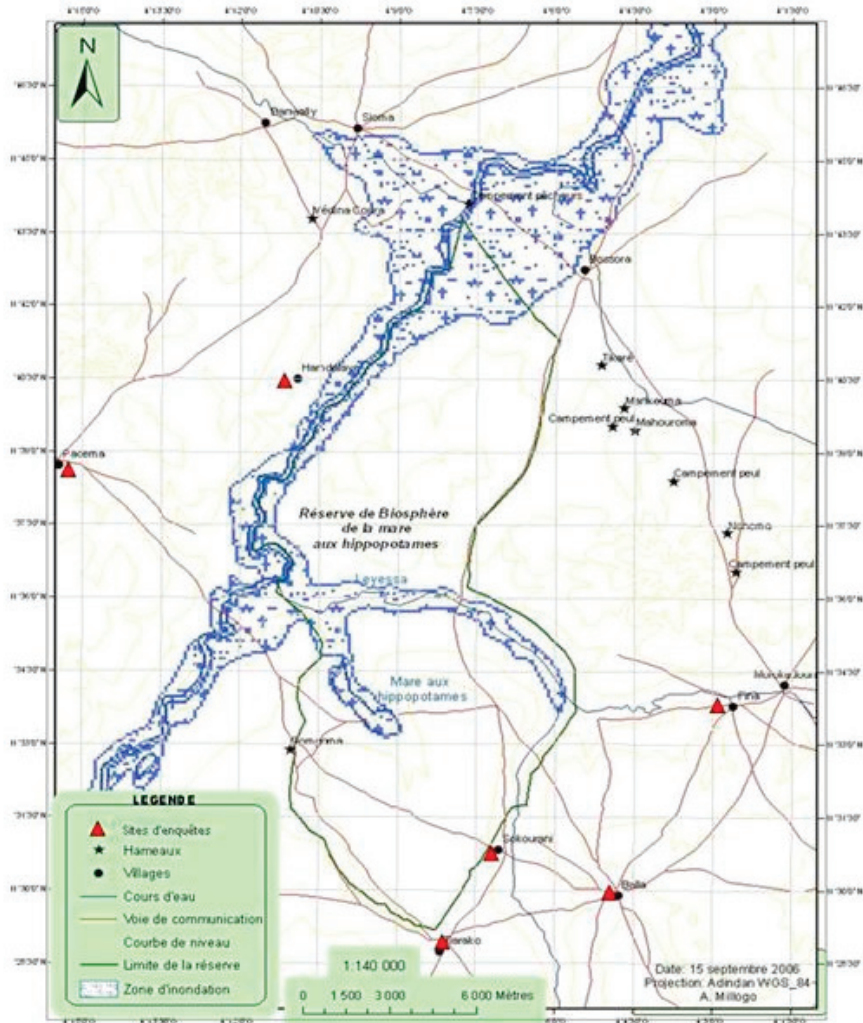


Figure 1: Map of the RBHM's location and survey sites

(*Tragelaphus scriptus* Pallas), roan antelope (*Hippotragus equinus* Desmarest), warthog (*Phacocoerus africanus*), oribi (*Ourebia ourebi* Zimmerman), duiker (*Cephalophus* sp.), waterbuck (*Kobus ellipsiprymnus* Ogilby), patas monkey (*Erythrocebus patas* Schreber) and baboon (*Papio anubis* Lesson) are also found in the reserve (Bouché 2005, ENGREF 1989). The avifauna is rich and varied (Poussy & Bakyono 1991), and the reserve also harbours numerous snake species (Roman 1980).

Fishermen living on the edge of the water body ensure the site's halieutical use and tourism function by bringing visitors to see the hippopotami.

The main problems encountered in the reserve are as follow (UCF/Hauts Bassins 2005):

- wild fires;
- poaching practised with the use of firearms, traps and hunting dogs;
- conflicts between hippopotami and fishermen in the form of destruction of nets, and conflicts between hippopotami and farmers in the form of extensive damage to crop fields;
- fishing using prohibited machines;
- illegal grazing through transhumant pastoralism;
- illegal use of green wood.

In order to control activities which are detrimental to the reserve's sustainability, the PAGEN or Partnership for the Improved Management of Natural Ecosystems (*Partenariat pour l'Amélioration de la Gestion des Ecosystems Naturels*) and the GEF/MAB UNESCO project have founded the Inter-village Association for Wildlife and Natural Resource Management (AGEREF- *Association inter-villageoise pour la Gestion des Ressources Naturelles et de la Faune*) which is a central community structure uniting organizations of the producers and growers working in the reserve's transition zone.

2.2 Data collection

This study aimed to make an inventory of rural knowledge about the potential of wild fauna as well as the indigenous methods implemented for the preservation of the Mare aux Hippopotames Biosphere Reserve (RBMH).

Data was collected by means of formal surveys in six villages bordering on the RBMH and in the fishing camps situated in the reserve (Figure 1). These villages were chosen because of their accessibility and proximity to the water body. The survey sample consisted of 8 to 9 households selected at random in each village, irrespective of ethnic groups.

The survey was conducted in the national language Dioula and focused on data related to:

- the economic activities in the study zone;
- knowledge of wild fauna;
- the reserve's importance for the population.

Despite the guide questionnaire that had been drawn up, interviews were conducted in a semi-structured manner, following the accelerated participatory research method of Gueye & Freud Emberger (1991). The interviews were supplemented with field observations during pedestrian surveys along specific transects (Burnham *et al.* 1980, Buckland *et al.* 1993).

2.3 Results

2.3.1 Economic characterization of the study zone

This study made it possible to determine the population's structure and to make a list of the economic activities conducted in the riparian villages.

1. Structure of the population

An average of 9 individuals of working age were counted in each household, including the head of the household, two spouses and six children, on average. The average age of the head of the household is 48 years, with a minimum of 22 years and a maximum of 90 years. In total, 50 households from the 6 sample villages were surveyed (Table 1).

Table 1: Structure of the survey sample

Villages	Sample			Average age in the households (years)
	Number of households	Number of persons surveyed	Percentage of the households (%)	
Bala	9	81	18	53
Fina	8	72	16	49
Padema	9	81	18	39
Hamdalaye	8	72	16	42
Sokourani	8	72	16	51
Tiarako	8	72	16	55
Total	50	450	100	48

The various ethnic groups in this study zone mainly consist of the indigenous Bobo population (84%) and migrants including the Mossi (12%), Fula and San (4%) who had come to the area in search of fertile land. With regard to religion, Muslims constitute the majority (60%), followed by Animists (32%) and Christians (8%).

2. Economic activities in the zone

More than a dozen economic activities are practised in the zone, with the main activity being agriculture, practised by 100% of the population, followed by stock farming (32% of the population). Other activities such as small trade and fishing are also practised by the inhabitants (Table 2).

Table 2: Distribution rate of the population (%) practising various economic activities

Activity	Main	Secondary I	Secondary II	Total
Agriculture	100			100
Stock farming	0	20	12	32
Tracking (patrolling)	0	12	2	14
Apiculture	0	4	0	4
Fishing	0	8	0	8
Literacy	0	2	0	2
Dressmaking	0	2	0	2
Small trade	0	6	2	8
Bicycle and moped repairs	0	2	0	2

Activity	Main	Secondary I	Secondary II	Total
Witch doctor	0	2	0	2
Tree nursery	0	0	2	2
Total	100	58	18	

The survey reveals that 18% of the population practise three activities, 58% of the population are involved in at least two different activities at the same time, and that 100% of the population practise at least one economic activity (Table 2).

The soaring population growth and land property pressures resulting from the monetization of agriculture greatly threaten the country's training opportunities. The Mare aux Hippopotames Biosphere Reserve is not the least affected area among them. In fact, there are ten peripheral villages and a multitude of farming hamlets around the reserve.

2.3.2 Knowledge of wild fauna

The results related to indigenous knowledge of wild fauna in the biosphere reserve hinge on the following points:

- species diversity of wild fauna in the reserve;
- wild fauna in the traditional medicine;
- cultural aspects of hunting and fishing activities;
- the significance of poaching in the reserve;
- conflicts between wild fauna and humans;
- interactions between wild fauna and domestic livestock;
- protection of wild fauna.

1. Species diversity of wild fauna in the reserve

The results from the surveys conducted among the inhabitants show that there are more than 37 species of wild fauna in the RBMH. The frequency (%) with which these species were cited shows that 30 of them are known by more than 50% of the village population. All species mentioned were referred to by their local Bobo name (Table 3). Field trips and pedestrian surveys made it possible to confirm the presence of 28 species of fauna which are the most well-known among the population. With regard to the remaining species cited, the presence of certain species (hartebeest, buffalo) in the reserve is disputed, whereas other species (red-flanked duiker, lion, and leopard) seem to have disappeared completely from the reserve (Table 3).

Table 3: List of wildlife species found in the reserve according to the population

Order	Family	Species			Frequency (%)
		Scientific name	Common name	Bobo name	
Artiodactyla	Bovidae/ Alcelaphinae	<i>Alcelaphus buse-laphus</i> ssp. <i>major</i> Pallas, 1766	Hartebeest	Ton, Tango	22*
	Bovidae/Bovinae	<i>Syncerus caffer brachyceros</i> Sparrman, 1779	Buffalo	Kibègnanga, Toou, Sigui	32*
	Bovidae/ Cephalophinae	<i>Sylvicapra grimmia</i> Linnaeus, 1758	Common duiker	Wourè, Djafing	84
		<i>Cephalophus rufilatus</i> Gray, 1846	Red-flanked duiker	Wa, Djawulé, Koo woura	50**
	Bovidae/Reduncinae	<i>Kobus kob</i> Erxleben, 1777	Kob	Paré, Song	48*
		<i>Redunca redunca</i> Pallas, 1767	Bohor reedbuck	Konkoro	38*
		<i>Kobus ellipsiprymnus</i> Ogilby, 1833	Waterbuck	Fougoula, Sissin	64
	Bovidae/ Tragelaphinae	<i>Tragelaphus scriptus</i> Pallas, 1766	Bushbuck	Fon, Mina	90
	Bovidae/ Hippotraginae	<i>Hippotragus equinus</i> Desmarest, 1804	Roan antelope	Saga gnagan, Daguè	76
	Bovidae/ Neotraginae	<i>Ourebia ourebi</i> Zimmerman, 1783	Oribi	Kouo, Dja	60
	Hippopotamidae	<i>Hippopotamus amphibius</i> Linnaeus, 1758	Hippopotamus	Diri, Dourou	98
	Suidae	<i>Phacochoerus africanus</i> Gmelin, 1788	Warthog	Kibè tèguè, Saga tèguè	84

Order	Family	Species			Frequency (%)
		Scientific name	Common name	Bobo name	
Carnivora	Canidae	<i>Canis adustus</i> Sundevall, 1847	Side-striped jackal	Demèkalé	74
	Felidae	<i>Felis silvestris</i> Schreber, 1775	Wildcat	Saga zakouma	52
		<i>Panthera leo</i> Linnaeus, 1758	Lion	Zara	6**
		<i>Panthera pardus</i> Schlegel, 1857	Leopard	Sogoo, Fiéfra	8**
	Viverridae	<i>Civettictis civetta</i> Schreber, 1776	Civet	Gotien, Wata	56
		<i>Genetta genetta</i> Linnaeus, 1758	Genet	Konoma	56
	Hyaenidae	<i>Crocuta crocuta</i> Erxleben, 1777	Hyena	Samiri	60
Herpestidae/ Herpestinae	<i>Herpestes ichneumon</i> Linnaeus, 1758	Mongoose	Sun	54	
Insectivora	Erinaceidae	<i>Erinaceus albiventris</i> Wagner, 1841	Hedgehog	Koundou	54
Lagomorpha	Leporidae	<i>Lepus capensis</i> Linnaeus, 1758	Hare	Moou	68
Primata	Cercopithecidae	<i>Papio anubis</i> Lesson, 1827	Baboon	Sèguè laba	74
	Cercopithecidae	<i>Erythrocebus patas</i> Schreber, 1775	Patas monkey	Founa, Fna pènè	80
	Cercopithecidae	<i>Cercopithecus aethiops</i> Linnaeus, 1758	Green monkey	Founa, Lè fna	84
Proboscidea	Elephantidae	<i>Loxodonta africana</i> Cuvier, 1825	Elephant	Koro	94
Crocodylia	Crocodylidae	<i>Crocodylus niloticus</i> Laurenti, 1768	Crocodile	Yiloo, Yilé, Bamba	74
Squamata	Pythonidae	<i>Python regius</i> Shaw, 1802 et <i>P. seaba</i> Gmelin, 1788	Python	Sansa, Samia sa	54
	Viperidae	<i>Bitis arietans</i> Merrem	Puff adder	Fotoro, Cotoro	80
	Elapidae	<i>Naja</i> sp.	Cobra	Diguiré, Dissiré	80
	Varanidae	<i>Varanus niloticus</i> Linnaeus, 1766	Nile monitor	Séguèrè	54
<i>Varanus exanthematicus</i> Bosc, 1792		Savannah monitor	Kui, Kudju	54	

Order	Family	Species			Frequency (%)
		Scientific name	Common name	Bobo name	
Rodentia	Thrionomyidae	<i>Thrionomys swinderianus</i> Temminck, 1827	Cane rat	Corè, Cognina	68
	Sciuridae	<i>Euxerus erythropus</i> E. Geoffroy, 1803	Squirrel	Tomgoulé, Guèrèni	62
	Hystriidae	<i>Hystrix cristata</i> Linnaeus, 1758	Porcupine	Sanè, bala	70
	Muridae/ Crycetomyiinae	<i>Cricetomys gambianus</i> Waterhouse, 1840	Gambian pouched rat	Toro, Tènè	56
Tubulidentata	Orycteropodidae	<i>Orycteropus afer</i> Pallas, 1766	Aardvark	Wuro kouéré, Timba	58

Legend

*species whose presence is doubtful

**species no longer found in the reserve

From the 37 species cited, 31 are mammals and 6 are reptiles. The mammal species come from eight orders: Artiodactyla, Carnivora, Insectivora, Lagomorpha, Primata, Proboscidea, Rodentia and Tubulidentata (Table 3). These species represent 24.2% of the wild mammals found in Burkina Faso (SP/CONAGESE 1999). The number of species mentioned by the population is higher than the number of species actually observed (Dibloni 2011). It is therefore necessary to improve monitoring in the reserve in order to preserve its rich wildlife diversity.

2. Wild fauna in traditional medicine

Four of the 35 species of wild fauna in the RBHM are used in traditional medicine or for supernatural forces. For instance, the tail bones of the hippopotamus are burnt and then used to treat sinusitis, and its skin is used to soothe itching. The paws and tail of the patas monkey, warthog hairs and porcupine quills are used for well-being or invoking spirits.

The knowledge of wild fauna species and of the pharmacological use of their organs is very poor in this region as compared to the knowledge of the riparian villagers in the total and partial biosphere reserves of Bontioli where at least 9 species were mentioned (Ouoba 2008). The survey sample could account for this poor knowledge.

3. Cultural aspects of hunting and fishing activities

For 50% of the population, there are customs linked to hunting. For example, the initiation of young boys, known as *Zomabara* in the Bobo language of the Tiarako village, entails spending 3 days and 3 nights in the forest. During this period, the young boys kill wild animals for food. The initiation ritual takes place every 7 years, during the month

of March or April when the population has free time. The individuals in charge of this custom, the *yèlèbiré* or *yèlèvo*, set the date for the initiation ritual during this time.

With regard to legal procedures related to this custom through various administrative texts, 60% of the population who recognize the existence of this hunting practise think that verbal or written authorization exists allowing the *yèlèbiré* or *yèlèvo* to honour this practise. The rest of the population (40%) did not respond.

The existence of customary fishing or *Forobanama* (in Bobo) is known by only 36% of the population. This is the practise of constructing a spillway, called *moudo* or *tiin* in Bobo, downstream of the water body where all fish are collected and distributed among the members of the community (Figure 2).



Figure 2: Photographs of the sharing of traditional fishing products (left: small fish; right: large, sliced fish) in the RBMH (© Dibloni O.T., 2010)

This customary fishing practise lasts one week, and on the last day, a family feast is prepared using the products from the *Forobanama*. At this occasion, the land leaders, known as *lagakoncé* in Bobo, make a number of sacrifices in order to ask the ancestors to bless their activities.

4. Poaching in the reserve

According to 30% of the population, poaching is still rife in the reserve and is practised especially during the dry season, between the months of November and May, after the bush fires. All animal species are targeted by poachers, but 33% and 26% of the population, respectively, believe that porcupines, hares and birds are the most hunted species (Figure 3).

In order to reduce poaching, the population suggests the following:

- developing the monitoring/patrol teams of the AGEREF through training and more equipment;
- intensifying patrols with the collaboration of forest services;
- raising awareness.

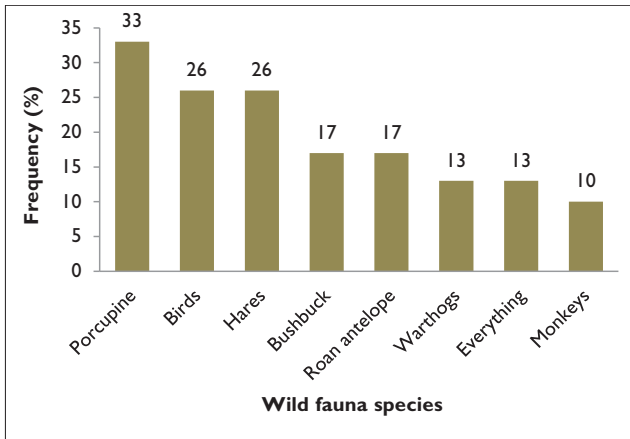


Figure 3: Citation frequency (%) of wild fauna species targeted by poachers

5. Conflicts between wild fauna and humans

This study aimed to make an inventory of the different types of damage caused by wild animals to human activity, and to list the indigenous methods for avoiding these inconveniences. With regard to this subject, 88% of the population claimed that wild animals destroy field crops as well as fishing nets. Damage to crops is caused by at least 9 species of wild fauna. Most of the damage is caused by monkeys (34.6%), hippopotami (29.6%), elephants (13.6%) and six other species.

Damage caused by hippopotami was especially noted in the Padema department where fatal accidents involving fishermen have been recorded. Fatal accidents take place during the females' calving season with the most recent cases being the death of a fisherman and serious injuries sustained by another individual whom we were able to see before he was admitted to the regional hospital centre Souro Sanou in Bobo Dioulasso in April 2008.

Damage caused to crops by wild fauna mainly affects grains, as cited by 56% of the population, cotton (19%) and orchards (Figure 4). The destruction of fishing nets represents 9.2% of all cases. Damage caused by animals is observed throughout the year, but occurs more frequently during the rainy season.

In order to fight against wild fauna intrusions and minimize risks, the following measures have been taken by the population and development projects: guarding the fields, using noise, fire and smoke to deter the animals, putting up scarecrows or setting up fields at a considerable distance from the reserve.

According to the surveys, the RBMH has been witness to multiple cases of wild-life-human conflicts. The most frequent cases are related to crop damage caused by monkeys, hippopotami and elephants, as well as damage to fishing nets caused mainly by hippopotami. These conflicts are generally known to occur in the different protected areas of Africa (Ouada *et al.* 2005, Packer *et al.* 2006, Danquah *et al.* 2006).

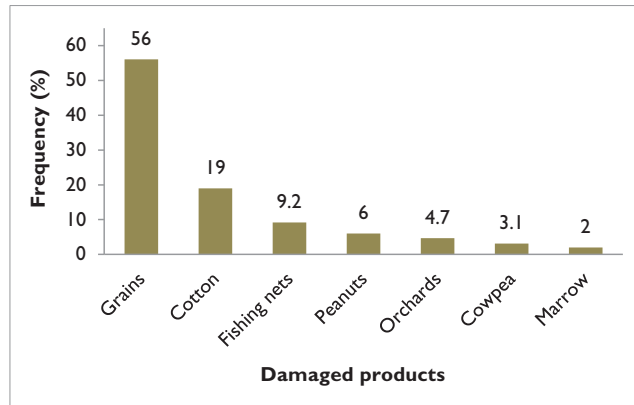


Figure 4: Citation frequency (%) of products damaged by wild fauna

6. Interaction between wild fauna and domestic livestock

In order to determine the possibility for cohabitation between wild fauna and domestic animals, 62% of the interviewed population (composed of Fula stock farmers and Bobo agropastoral farmers) claimed to not have any knowledge of this type of cohabitation or that it has never been possible. However, 38% of the population claimed that this cohabitation existed between herbivores at least thirty (30) years ago.

This is the case for the following groupings:

- small domestic ruminants (sheep and goats) with bushbuck, cited by 26% of the population;
- cattle with buffalo, cited by 8% of the population;
- donkeys with waterbuck, cited by 4% of the population.

According to 6% of the population, this cohabitation led to certain skin diseases in domestic livestock.

7. Protection of wild fauna

This section is concerned with listing the « totem » species, the population's knowledge regarding species which are fully protected by the State of Burkina Faso, the activities which are detrimental to the survival of wild fauna, and the steps that need to be implemented in order to prevent the extinction of wild mammals in this heritage site.

(a) Totem species or wild species protected by traditions

There are approximately 18 species of wild fauna which the riparian populations are prohibited to kill or consume, including 17 species among the Bobo people and 5 species among the Mossi people. The species that were listed are mainly birds, reptiles, rodents, primates, bush pigs and carnivores (Table 4). The species which are considered totem animals in several families are especially monkeys and pythons, cited by 31% of the population, followed by the hippopotamus, leopard, crocodile, elephant, squirrel,

monitor lizard, hyena, etc. The families from indigenous riparian populations with the local surnames of MILLOGO, DAO, KONATE and OUATTARA from the Bobo ethnic group have 12, 7, 5 and 4 wild animals as their totems, respectively (Table 4). The local surname SANOU, from the Bobo ethnic group, only has the Nile monitor as its totem species. Among the Mossi migrants, the BELEM and BADINI consider the python their totem animal, whereas the SAWADOGO have the leopard as their totem animal. The BAGAGNAN family's totems are the python, elephant and hippopotamus.

Table 4: Number of totem wild fauna species per local surname

<i>Animal species</i>	<i>Sanou</i>	<i>Ouattara</i>	<i>Millogo</i>	<i>Konate</i>	<i>Dao</i>	<i>Bagagnan</i>	<i>Badini</i>	<i>Sawadogo</i>	<i>Belem</i>	<i>Total</i>
Crocodile		x	x	x						3
Nile monitor	x	x	x							3
Savannah monitor					x					1
Tortoise			x							1
Royal python			x	x	x	x	x		x	6
Puff adder					x					1
Squirrel		x	x							2
Aardvark					x					1
Monkey				x	x	x				3
Hyena			x		x					2
Lion			x		x					2
Leopard			x	x				x		3
Porcupine			x							1
Buffalo						x				1
Elephant			x			x				2
Hippopotamus			x	x						2
Wild guinea-fowl			x							1
Francolin		x								1
Total	1	4	12	5	7	4	1	1	1	

While the ban to kill or consume these wild fauna species originates from customary tradition, Islam also has an influence here, especially with regard to primates and certain reptiles.

Despite the totemic character and value of certain animal species, some of them are no longer found in the region. This is true of large feline species such as lion and leopard. The surveys have also not been able to confirm the presence of buffalo.

(b) Knowledge of wild fauna species which are protected by the State

The majority of the village population (90%) recognizes that some species are indeed fully protected by the State. According to this population, there are approximately 15 such species of which the most well-known are hippopotamus and elephant, cited by 77.8% and 73.3% of the population, respectively. They are followed by crocodile, lion and leopard, cited by 8.9% and 6.7% of the population, respectively.

(c) Knowledge of activities which are harmful to wild fauna and suggestions for some conservation activities

The activities which are detrimental to the survival of wild fauna are known by more than 92% of the population. The most destructive activity in the RBHM is poaching, characterized by the presence of rifle cartridges, leghold traps, cane rat traps, hunters' hides, wild fauna carcasses, smoker ovens, domestic livestock herds, etc. (Figure 5).



Figure 5: Photographs showing evidence of poaching observed in the RBMH (a. Leghold traps; b. Profile view of cane rat traps; c. Bird traps; d. Poachers' hide; e. Seized poachers' rifles)

Other threats include wild fires, logging, the presence of domestic animals, crop fields bordering on the reserve and population growth (Figure 6).

To improve wild mammal conservation, the population suggests seven types of activities which work towards reducing illegal or legal human activities in the RBHM.

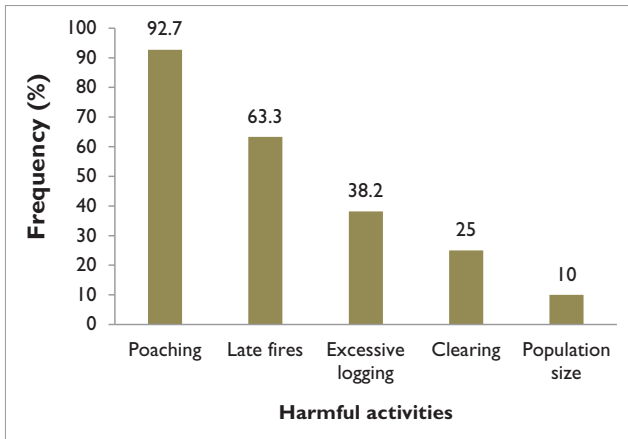


Figure 6: Citation frequency (%) of the importance of activities which are detrimental to wildlife conservation

The most important activities are the following:

- increasing monitoring/patrols in collaboration with forest services and the AGEREF trackers;
- setting up a committee for the fight against wild fires and excessive logging;
- raising awareness and obtaining equipment for the guards.

These suggestions were made by 82%, 34%, 18% and 16% of the population, respectively.

Despite all the difficulties encountered by wild fauna, a number of systems have been put in place for their protection at the national and international level. National protection systems include national parks, total and partial wildlife reserves, classified forests and the ratification of several conventions such as the Algiers Convention (1968) and the Washington/CITES Convention (1973) for the protection of certain endangered wildlife species (CONAGESE 1999, UICN 2006). At the traditional level, the protection system concerns totem species and zones of refuges or sacred woods.

2.3.3 The reserve's importance for the population

This section aims to:

- ascertain whether the population is aware of the reserve's status and of the benefits that the reserve holds for them;
- determine the factors favouring the presence or extinction of wild fauna species.

1. Status and benefits of the RBMH

The surveys conducted in 2006 show that 96% of the population is aware that the RBHM has been a world heritage site for the past 10 years. Approximately 91% of this population affirm that the improvement of vegetation diversity and the return of wild fauna thanks to restored vegetation are all benefits of the RBHM (Figure 7). The reserve also

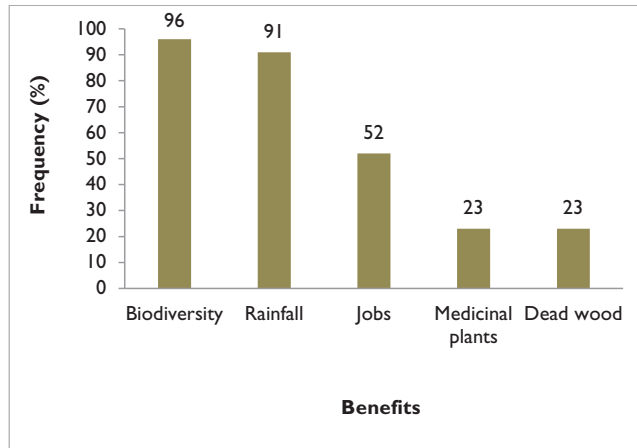


Figure 7: Citation frequency (%) of the reserve's benefits

creates jobs through the development of tourist guides, forest monitoring staff, commercial fishing, access to dead wood and so forth.

2. Factors favouring the presence or extinction of wild fauna in the RBMH

As previously mentioned, 68% of the population claim that red-flanked duiker, lion and leopard are species which are no longer present in the reserve. According to this population, certain species such as roan antelope have made a reappearance in the reserve thanks to the intervention of the PAGEN. The remainder of the interviewed population (32%) thinks that no wild fauna species have disappeared but rather that their numbers have decreased. This decrease in numbers was observed 24 years ago, 2 years after the intervention of the PAGEN in 2003.

Eight factors are considered to lead to the disappearance of wild fauna species or a decrease in numbers in the reserve. The factors which are considered to be the most threatening to the survival of wild fauna are poaching, bush fires and the impact of domestic livestock, mentioned by 62%, 52% and 28% of the population, respectively. The survey reveals that poaching is practised by the riparian populations as well as city dwellers who often set traps and use 12-calibre hunting rifles (Figure 8).

City dwellers entering the reserve with vehicles are considered to be especially responsible for decreasing numbers of wild mammals. In the Tiarako and Sokourani villages, the population emphasized the wild fauna carnage during the war between Mali and Burkina Faso in 1974.

However, 7 factors have favoured the reappearance or increase of wild fauna populations in the reserve, the main factor being intensive forest monitoring/patrolling, cited by 96% of the population (Figure 9). This intensive monitoring is a result of the combined efforts of the forest services and village guards of the AGEREF, as well as the opening of the forest services in the Padema department, cited by 18% of the population.

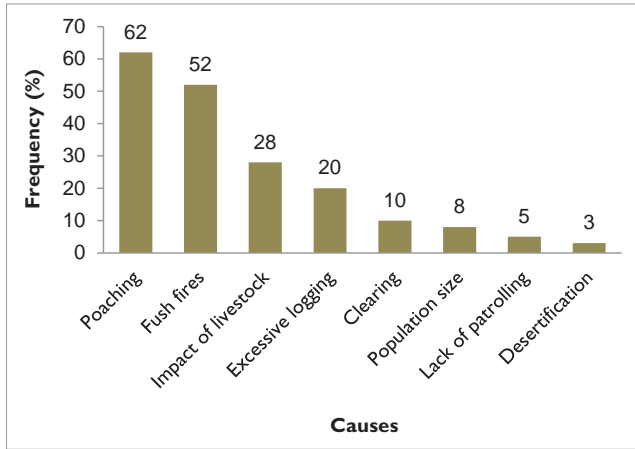


Figure 8: Citation frequency (%) of factors contributing to the disappearance of or decrease in wild fauna species

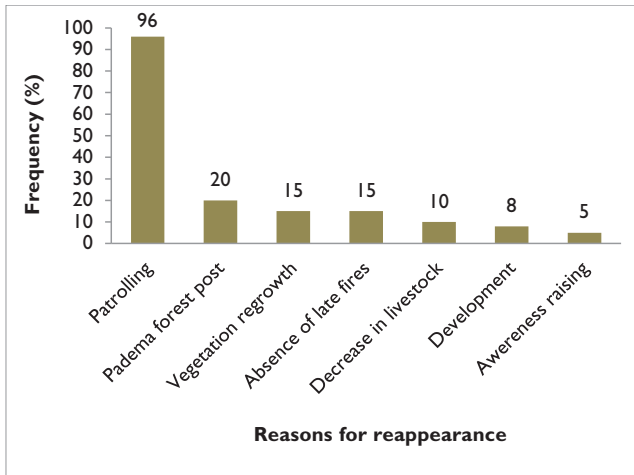


Figure 9: Citation frequency (%) of factors contributing to the reappearance of wild mammal species

With regard to the reserve as a wild fauna habitat, the population claims that the reserve is deteriorating due to poaching, bush fires and the impact of domestic livestock. These activities are proof that the peripheries close to conservation areas are coveted in the arid and semi-arid zones of Africa (Noirard *et al.* 2004, Okoumasou *et al.* 2004, Binot *et al.* 2006). All the activities leading to deterioration are believed to be diminishing thanks to the combined efforts of the forest service agents and the AGEREF guards introduced since the implementation of PAGEN activities. Given the importance of the reserve for the population, these activities must continue.

Thanks to its role in preserving animal and plant biodiversity, the RBHM is a perfect domain for educating and training present and future generations. The reserve also constitutes a source of currency for the country and a source of income for the population through the development of tourism. Moreover, the reserve presents inconveniences as well as advantages for the riparian village populations.

3. Conclusion

The results from this survey made it possible to ascertain that the riparian populations of the RBHM have knowledge of the wild fauna species living in the reserve. They are also aware of the threats to wild fauna and their habitats resulting from different human activities conducted in and around the reserve.

The riparian village populations estimate that there are more than 37 species of wild fauna in the RBHM. However, the actual number of wild fauna species is lower than the inhabitants' estimate, which confirms the progressive disappearance of fauna over the last few years. Each of the wild fauna species was referred to by their local Bobo name.

The surveys also revealed that the reserve as a fauna habitat is deteriorating due to poaching, bush fires and the impact of domestic livestock. The main deterioration factors detrimental to the survival of the reserve were cited by 62%, 52% and 28% of the population, respectively. The activities causing deterioration are allegedly diminishing thanks to the combined efforts of all the role players and beneficiaries of the RBHM. For the benefit of the riparian village inhabitants, the actions which are currently being implemented must continue, as the RBHM constitutes a source of income for the population with the development of tourism, and as it is the place where inhabitants perform certain socio-cultural rituals. In order to pave the way for improved biodiversity conservation in the reserve, it is important that the AfriMAB network provide the national MAB committee with financial and material resources necessary for development and capacity building for the Water and Forest agents and the local populations.

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12



Involving the Local Population in Protected Area Management

Implication de la population locale dans la gestion de l'aire protégée

ISAIA RAYMOND¹

Abstract

Sahamalaza-Iles Radama is the second biosphere reserve created in Madagascar in 2001 after *Mananara Nord* (North Mananara). The marine and coastal park constituting the bulk of the central zone of the biosphere reserve was created in 2007 under the Management of Protected Areas Act (COAP 2001). Mandated by the Madagascan government, Madagascar National Parks, a non-government organization (NGO) managing the national protected areas estate, chose to manage the national park and biosphere reserve under a light structure in terms of personnel. However, this institution encourages the dynamic participation of the local population in collaborative management of this new protected area. New organizations have been constituted at the grassroots level as well as inter-community. Structures existing before the establishment of the protected area and directed by 'wise elders' were formalised and respected. Communication and exchange of information occurs between the different structures on the basis of the division of responsibilities.

Key words: co-management, pilot site, development support

Résumé

Sahamalaza-îles Radama est la deuxième réserve de biosphère créée à Madagascar en 2001, après Mananara Nord. Le parc marin et côtier constituant la majorité de la zone centrale de la réserve de biosphère est créé en 2007, sous la loi Code de Gestion des Aires Protégées (COAP 2001). Mandaté par le Gouvernement Malgache, Madagascar National Parks, organisation non gouvernementale gérant le réseau national des aires

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protégées de Madagascar a choisi la gestion, à la fois du parc national et la réserve de biosphère Sahamalaza-Iles Radama comme une structure légère du point de vu personnel. Cependant, cette Institution encourage la participation dynamique de la population locale dans la gestion collaborative de cette nouvelle aire protégée. Ainsi, des nouvelles organisations ont été constituées aussi bien au niveau des bases, des communes qu'entre les communes. Les structures existant avant la mise en place de l'aire protégée et dirigées par les 'sages', ont été capitalisées et respectées. La communication et l'échange d'informations se passent bien entre les différentes structures au vu du partage de responsabilités.

Mots-clés: cogestion, site pilote, appui au développement

I. Introduction

Involving the local population in the management of protected areas is a new policy adopted by Madagascar National Parks (MNP), particularly in the new systems of Madagascar's protected areas (protected areas created from 2003 onwards). The main objective is the effective conservation of the protected area's ecosystems and biodiversity. Sahamalaza-Iles Radama is the first protected area to have been selected by MNP as a pilot site for implementing this new management policy. The first reason is that Sahamalaza-Iles Radama is the first protected area created after the official declaration of the President of the Republic of Madagascar during the 2003 World Parks Congress held in Durban, at which Madagascar committed itself to increasing the surface area of protected areas from 1 700 000 to 6 000 000 hectares by 2012. The second reason is that the 153 200 ha marine and coastal protected area Sahamalaza-Iles Radama received the UNESCO designation "Biosphere Reserve" in September 2001 and was included in the "MAN AND BIOSPHERE" programme on 10 November 2001 (Wildlife Conservation Society WCS/Development Environment Consult DEC 2002). Therefore, the creation of Sahamalaza as a marine and coastal park not only constitutes a legal model for biodiversity conservation and management, but it is also an essential tool for the socio-economic development of local populations (PSSE 2009). The national legal framework for the management of protected areas is provided mainly by the COAP (*Code de gestion des aires protégées* — Management of Protected Areas Act) and its subsequent laws of enforcement. It is in this context, through the decree 2007-247 of 19 March 2007 that the bulk of the central area of the Sahamalaza Biosphere Reserve was legally instituted as a 26 035 ha national park, forming part of one of the protected area categories managed by MNP.



Despite its exceptionally rich biodiversity according to the Management Plan of Protected Areas Network (PLANGRAP 2001 — *plan de gestion du réseau des aires protégées*), the threat level experienced by the Sahamalaza-Iles Radama protected area is high at a marine and at a coastal ecosystem level. The progressive destruction of the habitats (Belshaw & Andriamandroso 1997) has an impact not only on the increasing scarcity of local endemic species, but also at a socio-economic and even cultural level.

With the aim of protecting and preserving the original natural and/or cultural heritage while at the same time providing a recreational and educational framework, the involvement of local populations in the collaborative management of this new protected area is encouraged.

This case study presents the manner in which this type of co-management of the new protected area occurs in collaboration, in a clear framework, and through structures which are representative of the majority of the local communities' members.

Prior to presenting the adopted methods and the results, we find it appropriate to first describe the studied environment.

2. Description of the environment

2.1 Administrative and geographical location

The Sahamalaza-Iles Radama Marine and Coastal Biosphere Reserve is situated on the north-western coast of Madagascar, straddling two administrative regions: the DIANA region in the north and the SOFIA region in the south (Figures 1 and 2). The geographical coordinates delimiting this biosphere reserve are indicated below:



Figure 1: The Sahamalaza-Iles Radama Biosphere Reserve

- Maximum Western boundary: 47° 38' 40" E
- Maximum Eastern boundary: 47° 46' 30" E
- Maximum Northern boundary: 13° 52' 20" S
- Maximum Southern boundary: 14° 27' 15" S
- Central point coordinates: 47° 42' 05" E / 14° 09' 50" S

2.2 Description of the biological environment

The Sahamalaza-Iles Radama Biosphere Reserve is made up of three major ecosystems: a 10 000 ha marine ecosystem with five islands, a 10 000 ha mangrove coastal ecosystem and a 11 100 ha forest ecosystem. The reserve contains a littoral forest in the north-eastern part of the Sahamalaza peninsula, a low-lying dry, dense, semi-deciduous forest on metamorphic rock, and a riparian forest growing in the cool soils along rivers and streams (Figure 3).



Figure 2: Sahamalaza-Iles Radama Biosphere Reserve
(Acknowledgement: I. Raymond)

The dry and littoral forests are habitat to 220 species of flora grouped into 68 families. With regard to fauna, there are nine species of lemur including two local endemic species, 41 bird species of which 16 are endemic to Madagascar, 20 reptile species, and 14 amphibian species including one local endemic species.

All of Madagascar's eight mangrove species can be found in the reserve's mangroves, which also shelter 76 bird species including 31 listed endemic Madagascan species, of which five are endangered according to IUCN criteria.

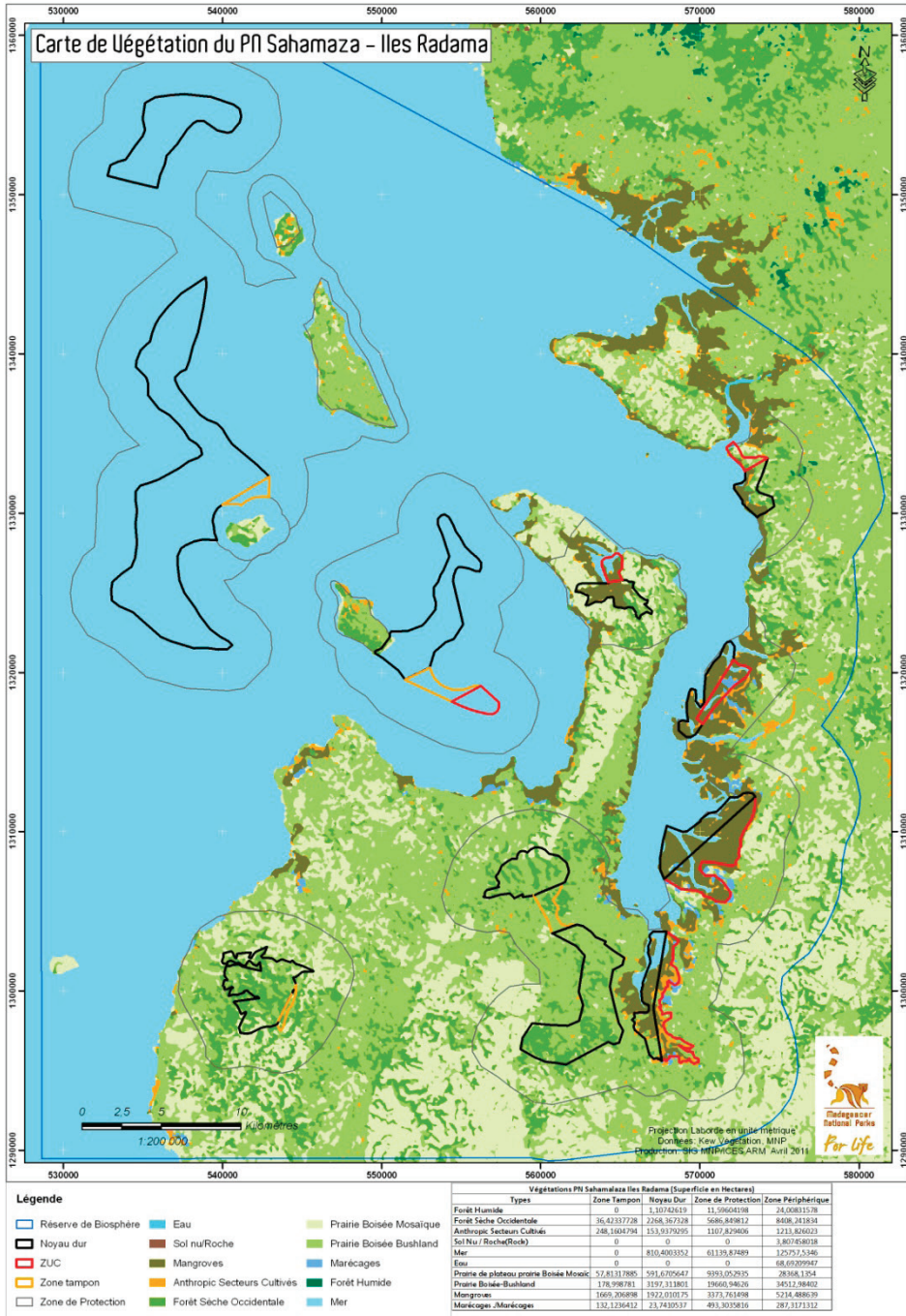


Figure 3: Map of the biosphere reserve's vegetation (Acknowledgement: I. Raymond)

While a reef site generally harbours between 80 and 110 species of coral and invertebrates as well as approximately 50 to 60 species of fish (Van der Veken 2009), the reserve's reef boasts a listing of 218 species of coral and invertebrates, and 168 species of fish.

The sea floor extending at shallow depths constitutes a special habitat for the 20 identified holothurian species, all of which are threatened by overharvesting (Rasolofomanana 2006).

2.3 Population

2.3.1 Origins

In this 153 200 ha reserve, the population is estimated at 48 476 inhabitants, with an annual growth of 2.3% (SAVAIVO 2003). These inhabitants live in 80 villages/hamlets in the Sahamalaza-Iles Radama National Park's peripheral zone. According to the oral tradition, the first inhabitants of the Sahamalaza-Iles Radama region were descendants of a founding couple that had come from Africa (macao). They then mixed with the surrounding populations, the Sakalava and the Tsimihety, and formed a local clan known as "Anadroadra". The native people thus form part of the ethnic group "Sakalava-Bemihisatra" which formed through the branch resulting from rivalries within the "Sakalava" kingdom prior to the "Merina" conquest in the 19th century. In the early 20th century, when the area was already under colonial regime, farmers and entrepreneurs were given ownership of a number of Radama islands. Subsequently, the region remained rather isolated until the recent boom in sea cucumber harvesting. This valuable resource attracted immigrants from other regions of Madagascar who settled in the coastal villages and often married local women. This explains the annual growth of 2.3%.

2.3.2 Way of life of the population

The permanent population's traditional way of life is presumed to have little impact on their environment (SAVAIVO 2003). The immigrant population, however, presents serious risks (WCS/DEC 2002). Although they make use of nets and motor-driven boats, they not only endanger the species which they fish and harvest for commercial purposes (sea cucumber, sharks, fish, prawns and shrimp) but also marine turtles, which entangle themselves in the nets (WCS/DEC 2002). The indigenous Sakalava consider it "fady" (taboo) to kill or consume marine turtles and lemurs, a belief that had been protecting the species prior to the immigrants' arrival. It is also considered "fady" to fish at night or during the day on Tuesdays and Thursdays, especially in sacred sites, 13 of which are found in the biosphere reserve. The immigrant population is composed of different tribes, which choose not to respect the local taboos. This poses significant problems for the indigenous population as well as for the protected area's managers.

2.3.3 Activities of the population

Anthropic activities such as logging, deforestation for rice-growing, bush fires for the renewal of zebu pastures, hunting birds and lemurs for family consumption, as well

as illegal fishing constitute the main pressures threatening the biodiversity of the biosphere reserve.

Currently, these human activities are beginning to have a negative impact on the ecosystems. The most significant natural process is the sedimentation of coral reefs (Van Der Veken 2009). It is evident that the deforestation of the large rivers' drainage basins is the reason for the increased sedimentation in the biosphere reserve.

Management is aware of this situation and used their knowledge to raise awareness among the local populations and involve them in the management of the protected area.

3. Methodology

Four methodological approaches were adopted in order to involve the population in the management of the protected area: raising awareness, creating associations, assigning responsibility and development support.

3.1 Raising awareness and creating associations

Much like on a global scale, raising the local population's awareness of the ecological, economic and socio-cultural objectives and importance of the new protected area to be created is a crucial activity. In Sahamalaza, management grouped the people aware of the situation into an association.

In villages and groups of smaller villages locally known as "fokontany", a Local Grassroots Committee (CLB—*Comité local de base*) was formed, consisting of fishermen, breeders, farmers, teachers, and even traders (Annex 1).

At the community level, a Communal Dialogue Organization (SCC—*Structure de concertation communale*) consisting of officers from the CLBs was created. The SCC has a liaison role and serves as a link between the CLBs and higher authorities (community and district).

Among the five communities forming the Sahamalaza area, the CLBs are grouped into one federation. This federation is in charge of monitoring each CLB's activities and the working-out and implementation of each "dina commun", or local law, created at the general meeting of CLB members.

Also at the community level, a "Wise Elders" Association comprised of elders and traditional authorities was founded. This association's role is mainly that of conflict management in all existing associations and even among management and administrative authorities. In addition, the members of this association are also the guardians of tradition. They ensure that sacred sites inside (15 sacred sites) as well as outside (20 sacred sites) of the protected area are respected.



Figure 4: 2008 photograph of the COSAP officers

In order to effectively direct the activities of the existing associations in the protection of the protected area and to support the managers, an Orientation and Support Committee for the Protected Area (COSAP—*Comité d'orientation et de soutien à l'aire protégée*) was created between the communities (Figure 4).

It is also noteworthy that all these associations are legal at the district level. The officers of each association were appointed during elections held at the general meeting.

3.2 Assigning responsibility to the population

In November 2008, a meeting of each association's representatives was held in the meeting room of Sahamalaza National Park management in order to identify and sign each association's responsibility charter.

3.3 Development support

With the aim of improving the living conditions of the associations' members and in order to motivate them further in the park's conservation activities, management addressed their request for support to sponsors and non-governmental organizations.

4. Results

4.1 The created associations (Table 1)

From 2006 up to the present, 32 CLBs were created. Currently there are only 2 “fokontany” lacking such a committee.

During the course of 2006, five SCCs were also created.

At present, each community succeeds in grouping elders and the traditional authorities into one Wise Elders Association.

The COSAP, which groups all associations existing between the communities, was formed in September 2008.

Table 1: List of created associations

Type of association	Year of creation	Number	Number of members	Existence
Local Grassroots Committee (CLB)	2006	32	640	On average 30 members per fokontany
Dialogue Organization (SCC)	2006	5	40	8 officers per community
CLB federation	2007	1	8	Between the communities (8 officers)
Wise Elders Association	2007	5	75	On average 15 members per community
Sahamalaza COSAP	2008	1	25	5 officers per community

4.1.1 Note:

- All the created associations are definite. The officers are elected by universal suffrage.
- Apart from the policies and procedures, each association drew up a “dina” or local law.
- In 2010, a CLB federation “dina” was drawn up. It was signed by administrative authorities such as the Regional Management of the Environment and Forests (*Direction Régionale de l’Environnement et Forêts*), the Regional Management of Fishing and Halieutical Resources (*Direction Régionale de Pêche et des Ressources Halieutiques*), and the District Head (*Chef de District*). This “dina commun” was approved by the Court of First Instance (*Tribunal de Première Instance*) in December 2011. Currently, this “dina” is applicable in the entire Sahamalaza-Iles Radama reserve.

4.2 The associations’ achievements

4.2.1 The CLB’s achievements (Table 2)

The members of the CLB, in collaboration with the MNP team, ensure the completion of all the park’s technical activities, including surveillance and monitoring, as well as the construction and maintenance of conservation and ecotourism infrastructure.

Table 2: The technical achievements of the CLBs and MNP

Type of activity	Quantity	Observation
Patrol of the park	3900 daily hours/year	10 to 15 days/month
Conservation and ecotourism infrastructure in place	4 guard posts	In 2008
	1 control gate	In 2008
	147 72 km of external boundaries are marked out. 61 km of the central core’s boundaries of the park are marked out.	All the park’s land and coastal plots are marked out, i.e. 70% of all the boundaries.
	14 600 km of firebreaks 2 reception posts	On average, 3 km per year In 2011
Habitat restoration	40 ha of mangrove	In the damaged areas
	60 ha of dry forest	

4.2.2 The achievements of the dialogue organizations

Thanks to the SCCs’ request for technical support submitted to the Lemur Conservation Association (AEECL—*Association Européenne pour l’Etude et la Conservation des Lémuriens*) and the Wildlife Conservation Society (WCS) in 2006, the members of the CLBs were able to receive training in intensive rice-growing systems and in tree nursery preparation and reforestation techniques (Figure 5).

In 2008, one of these five SCCs received financing from the WIO-LaB Project National Focal Institution



Figure 5: 2010 photograph showing the tree nursery materials financed by WIO-LaB (Nairobi Convention)

and UNEP/Nairobi Convention for the restoration of 40 ha of damaged mangrove in the Sahamalaza National Park (Figure 6).



Figure 6: 2011 photograph showing the restoration of mangroves in the park's peripheral zone

4.2.3 The achievements of the Wise Elders Association

In April 2009, at the dawn of the political crisis in Madagascar, a large conflict between the park's management and a number of local Sahamalaza politicians was resolved thanks to the Wise Elders Association. The aforementioned politicians had been allowing hundreds of illegal fishermen from four of Sahamalaza's neighbouring districts to enter the park's marine plots free of charge. In violation of the COAP law (Management of Protected Areas Act — *Code de gestion des aires protégées*), these fishermen were bringing hundreds of pirogues and fine-mesh nets into the central core (prohibited zone) of the park. The Wise Elders became aware of this undesirable situation and called a meeting of all the local and regional persons in charge in order to solve the problem collaboratively. The very same day all the illegal fishermen were expelled from the national park.

4.2.4 The COSAP's achievements

With the aim of reinforcing public awareness, the COSAP organises and carries out two events each year. One of the events, World Environment Day, takes place on the 5th of June (Figure 7). The other event, the Lemur Festival, is held on the 23rd, 24th and the 25th of September. During these demonstrations, all the village inhabitants come together in the community.



Figure 7: Prince Arana IV gives a speech during the World Environment day celebrations in 2010 (awareness speech)

4.3 Development of micro projects (Table 3)

The support provided by the sponsors and NGOs focus particularly on drinking water, rice-growing, bee-keeping, improved fishing, the restoration of damaged forest habitats, the transfer of natural resource management, rain-fed cassava cultivation, poultry farming, and the building of schools.

Table 3: List of completed micro projects

Sub-project	Number	Number of beneficiaries	Sponsor/NGO	Observation
Well	12	120 households	AEECL	In 4 villages
Well	3	80 households	US embassy	2 villages
Hydro-agricultural dam	1	80 households	RDSP/World Bank	1 village
Bee-keeping	6	90 households	RDSP/World Bank	6 associations in 6 different villages
Sea fishing	10	150 households	RDSP/World Bank	10 associations in 10 villages
Mangrove restoration	10	10 villages (CLB)	Wio-LaB/Nairobi Convention	Buffer zone of the national park
Natural resource management transfer	8	8 villages (CLB)	UNDP	Zone adjoining the protected area
Crab fishing	1	25 households	UNDP	Reference site
Bee-keeping	1	120 PAPs	World Bank	Population affected by the project of the creation of the park (PAP— <i>Population affectée par le projet de création du parc</i>)
Poultry farming	1	639 PAPs	World Bank	
Improved fishing	1	347 PAPs	World Bank	
Improved rice-growing	1	PAPs	World Bank	
Rain-fed cassava cultivation	1	PAPs	World Bank	
Building of schools	3	3 villages	AEECL	
Payment of teachers' salaries	42	8 villages	AEECL	Non-state employee teachers

5. Discussion

In order to facilitate communication between management and the local population, social structures at the local level were needed, hence the creation of 32 CLBs at the grass-roots level (fokontany), five Dialogue Organizations and five Wise Elders Associations in the communities, a federation of CLBs and a COSAP at the intercommunity level. Also, in 2011, an Ecotourism Guides Association was created at the regional level. During and after their creation, all the associations benefitted from technical training, according to their needs. Given their awareness of the protected area's importance, especially in the field of biodiversity conservation and the sustainable use of natural resources, each association assumed their responsibilities. For example, the members of the CLB patrol

the park at least ten days a month. The COSAP continually raises awareness among the villagers through field missions and the organisation of festivities such as the World Environment Day celebrations and the Lemur Festival.

Technical and financial support from the sponsors and NGOs increase the associations' motivation to fulfil their responsibilities by means of mission allowances and also through the development of micro projects.

One can say that the outcome of each party's intervention has a positive impact on the gradual reduction of the pressures threatening the protected area (refer to Figure 8 below).

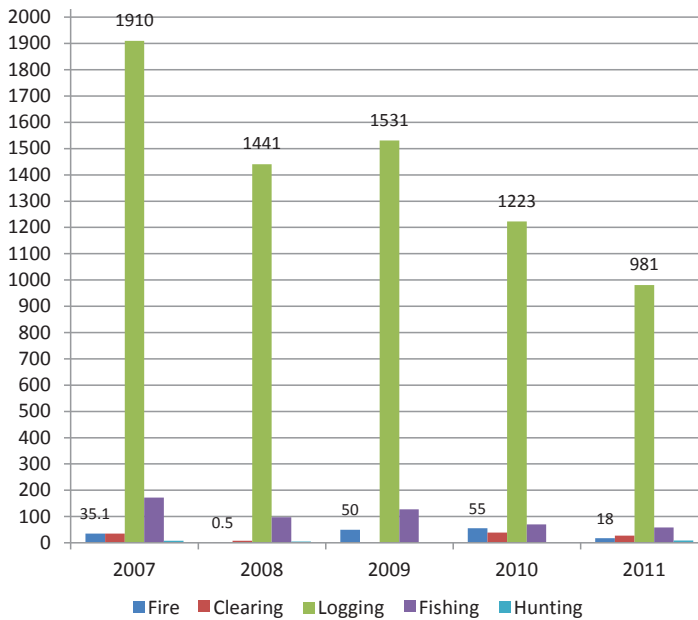


Figure 8: Annual progression of pressures

In Sahamalaza, the bush fires (fire), the clearing of forests (clearing), selective logging (logging), illegal fishing and harvesting of prawn, crab, shark, and holothurians, as well as the trap hunting (hunting) of rare birds and lemurs constitute the main pressures threatening the protected area. In comparison with the year when the associations were created (2007), the pressures have shown a decreasing trend, as is the case with the logging of mangroves, of which there were 1910 stumps in 2007, decreasing to 981 stumps towards the end of 2011. It is the illegal farmers from Nosy Be (situated 100 km north of Sahamalaza) who ship Sahamalaza's wood by dhow.

6. Conclusion

As the local Sahamalaza populations are aware of the progressive damage to natural resources, it is easy to involve them in the activities concerning the protected area. The created associations participate in awareness raising activities, the patrolling of the

park, the monitoring of the ecology, the setting up of conservation infrastructures and firebreaks, the restoration of damaged habitats, and conflict management.

Support for capacity building and for the development of these communities was ensured by management together with the partner institutions in order to motivate the local partners.

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Annexure I: List of the created CLBs

<i>Community</i>	<i>Fokontany</i>	<i>Name of the committee</i>	<i>Date of creation and drawing up of the dina</i>
Anorotsangana	Antetezambato	NANTO	21 and 22/06/06
Anorotsangana	Betsiriry.	MAMY	23 and 24/06/06
Anorotsangana	Anorontsangana	MEVA	25 and 27/06/06
Anorotsangana	Berafia	DAUPHIN	28 and 29/06/06
Anorotsangana	Lavalohalika	AKOMBA	30 and 31/06/06
Ankaramibe	Ambaliha	ANKOAY	08 and 10/09/06
Anorotsangana	Antanambao Andranomody	JERIMIRA	12 and 13/10/06
Anorotsangana	Bezavona	MAMIRATRA	14 and 15/10/06
Anorotsangana	Ambodimanga Sud	MIARADIA	16 and 17/10/06
Maromandia	Anjajaja	TSARAMANDROSO	24/09/06
Befotaka	Antanimbarbe	AVOTRA	18/09/06
Befotaka	Ampohara	MAEVATSARA	21/11/06
Amboloboza	Ankingabe	VEROMANITRY	16/09/06
Amboloboza	Andaveno III	RAVIMAITSO	18/09/06
Amboloboza	Ampasimpitily	FIVOARNA	21/09/06
Amboloboza	Ambalahonko	ANTELY	31/08/06
Amboloboza	Amboloboza	FITAMIA	2006
Amboloboza	Antafiabe	RAVIMAITSO	2006
Amboloboza	Ambalahonko	HAZOMANANJARA	2006
Amboloboza	Ambinada	MATAMBELONA	2006
Amboloboza	Ampanotoa	VOLAMAITSO II	2006
Maromandia	Maromandia	LOVINJO	2006
Maroamndia	Maromandia	TSARAJORO	2006
Maromandia	Ankitsika	VARATRAZA	2006
Maromandia	Tanandava II	FANIHY	2006
Maromandia	Tanandava II	TSARAFAMINDRA	2006
Maroamndia	Marovato Sud	VOROMAHERY	2006
Maromandia	Bevoay/Maromandia	TSILAVONDRIVOTRA	2006
Maromandia	Maromandia	FPM	2006
Maromandia	Maroamndia	SANTATRA	2006
Maromandia	Maroamndia	TARATRA	2006
Maromandia	Maroamndia	BALISAMA	2006



Potential of Community Resources Management Areas as Forest Corridors in Western Ghana

Potentiel des zones de gestion des ressources communautaires en tant que corridors forestiers à l'ouest du Ghana

WILLIAM ODURO¹ • EMMANUEL DANQUAH²

Abstract

Forest elephants in Ghana live in small isolated populations and number less than 1 000 individuals in total. In western Ghana, the Bia Biosphere Reserve is an isolated area but comprises the largest forest elephant population within the Bia-Goaso Forest Block (BGFB). To ensure their long-term survival, a number of possible forest corridors and shelterbelts have been proposed by several authors. In this paper we report on the status of forest elephants in the area and discuss the potential of community resources management areas (CREMAs) as forest corridors in enhancing elephant movement in the BGFB. The CREMA concept has gained considerable attention in recent years and it is the Ghana Wildlife Division's approach to link the conservation of biological diversity within off-reserve areas to the benefit of social and economic development of fringe communities. This is in line with UNESCO's Man and the Biosphere's objective for achieving a sustainable balance between conserving biological diversity and promoting economic development. A major challenge however, is to design internal forest corridors within the CREMAs where little or no human activity takes place that will not only ensure the long-term viability of species and ecosystems, but also be politically and economically acceptable to local communities and government. A number of recommendations required for the corridors to be effective are proposed.

Keywords: CREMA, Mpameso, land, stream, community, wildlife, corridor, crop, rural, economic

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Résumé

Les éléphants de forêts au Ghana vivent en petites populations isolées avec un nombre inférieur à 1,000 individus au total. À l'ouest du Ghana, la réserve de biosphère de Bia est une zone isolée comprenant cependant la population d'éléphants de forêts la plus importante au sein du peuplement forestier de Bia-Goaso (BGFB). Pour garantir leur survie à long terme, un certain nombre de corridors forestiers et de ceintures de protection possibles a été proposé par plusieurs auteurs. Dans ce document, nous faisons le rapport du statut des éléphants de forêts dans la zone et portons notre réflexion sur le potentiel des zones de gestion des ressources communautaires (CREMA) en tant que corridors forestiers afin d'améliorer les mouvements des éléphants dans la BGFB. Le concept des CREMA a bénéficié d'une attention considérable au cours des dernières années et constitue l'approche de la Division de la faune au Ghana pour établir un lien entre la conservation de la diversité biologique au sein des limites extérieures des zones de réserves et l'avantage du développement social et économique des communautés périphériques. Il est en harmonie avec l'objectif Homme et Biosphère de l'UNESCO visant à la réalisation d'un équilibre durable entre la conservation de la diversité biologique et la promotion du développement économique. Néanmoins, l'un des enjeux majeurs est de concevoir des corridors forestiers à l'intérieur des zones de CREMA où l'activité humaine est minimale ou inexistante, qui non seulement assureront la viabilité des espèces et des écosystèmes sur le long terme mais seront également acceptées, politiquement et économiquement, auprès des communautés locales et du gouvernement. Un certain nombre de recommandations nécessaires pour que ces corridors soient efficaces est proposé.

Mots-clés: CREMA, Mpameso, terre, fleuve, communauté, faune, corridor, récoltes, rural, économique

1. Introduction

Much of Africa's biodiversity coincides almost exactly with areas where indigenous people live, hence these areas represent some of the most exploited environments for agriculture, hunting and other human activities (Terborgh & Peres 2002, Colchester 2004, Attuquayefio & Fobil 2005). Escalating human population growth, industrial logging, slash-and-burn farming, road and infrastructure expansion, and overhunting resulting in high rates of habitat loss and modification, have reduced rainforests in West Africa to 8–12% of their former extent (Naughton-Treves & Weber 2001). These habitat modifications potentially have important consequences for associated fauna assemblages, with significant differences being apparent between naturally occurring and generalist assemblages. Although many native fauna are negatively influenced by habitat conversion, some generalist species may adapt, and thrive, within the modified environment (Struhsaker 1996, Barnes *et al.* 1995, Fonseca & Robinson 1990).

The African Elephant Status Report 2007 (Blanc *et al.* 2007) estimated that the total number (definite) of elephants (*Loxodonta africana*) in West Africa in 2007 was about 7 487, compared to 5 458 elephants in 2002. Nevertheless, elephant range in West Africa is less extensive compared to other regions and found in small fragments scattered across forest, savanna and other habitats. Ghana is fortunate to share several elephant populations with neighbouring countries. Elephants move between Ghana and Burkina Faso, across the eastern border with Togo (Okoumassa *et al.* 1998), and possibly across the western border with Cote d'Ivoire (i.e. Bia-Goaso-Diambarakrou Wildlife Corridor). Available evidence however indicates that elephants may not be actively using the Bia-Goaso-Diambarakrou Wildlife Corridor currently because of increasing threat from expanding agriculture.

The Action Plan for the Management of Transfrontier Elephant Conservation Corridors in West Africa (Sebogo & Barnes 2003) emphasizes the need for cooperation between neighbouring countries to manage transfrontier elephant corridors because transfrontier elephant populations account for more than half of the forest elephants in West Africa. The successful management of transfrontier ranges will make a significant contribution to the conservation of West African elephants. Two options can be used to overcome the problem of expanding agriculture within the Bia-Goaso-Diambarakrou Wildlife Corridor: improving habitat through reforestation of degraded areas; and the creation of forest corridors between major elephant strongholds, particularly the Bia Biosphere Reserve. This will aid elephant movement, thus enlarging effective population sizes (Beier & Noss 1998, Parren & Sam 2003). Forest corridors provide the hope that one can reverse the consequences of habitat fragmentation in a human-dominated landscape. A forest corridor that links two patches of isolated habitat reduces the risk of genetic isolation and allows elephants to access a wider range of resources, especially if some resources are available only during certain seasons. Although we tend to think of elephants as being the principal beneficiaries, corridors benefit a wide range of organisms (Tewksbury *et al.* 2002). Again, corridors that are large enough to protect elephants will of course be important for general biodiversity conservation.

In this paper the potential of forest corridors in enhancing elephant movement in delineated areas in Bia Biosphere Reserve is discussed based on the Ghana Wildlife Division's concept of community resources management areas (CREMAs). CREMAs attempt to link the conservation of biological diversity within off-reserve areas to the benefit of social and economic development of the community. This is in line with the Biosphere Reserve concept and key components in UNESCO's Man and the Biosphere (MAB) Programme's objective for reconciling and achieving a sustainable balance between the conflicting goals of conserving biological diversity, promoting economic and social development and maintaining associated cultural values. The current status of the forest elephant populations in the area is reported and the expectations by the local population in conserving elephants (Parren & Sam 2003) assessed. A number of recommendations required for the corridors to be effective are also proposed.

2. Materials and Methods

2.1 Bia-Goaso Forest Block (BGFB)

The BGFB in western Ghana forms some 5 000 km² of the Ghana High Forest Zone, extending from latitudes 6.15 to 7.20 degrees north and longitudes 2.24 to 3.16 degrees west, immediately east of the Ghana-Cote d'Ivoire border (Figure 1).

Land tenure consists of several protected areas and communal lands with varying degrees of human settlement and farming practices, extending south of Sunyani, to the west of the Tano River and to the Ghana-Cote d'Ivoire border. Protected areas include two wildlife reserves (Bia Resource Reserve and Bia National Park, referred to as Bia Biosphere Reserve (BBR)), nine forest reserves (Asukesi, Bia Tano, Mpameso, Bonkoni, Ayum, Subin, Bonsam Bepo, Bia North and Krokosua Hills which includes a globally significant biodiversity area) and three shelterbelts (Bia, Goa and Abonyere) in which the settlement of people is prohibited. The protected areas form a significant proportion of the study area and are under the control of the Forestry Commission of Ghana. Communal lands are areas where people and some wildlife are both resident and have to co-exist. Immigration of people into communal lands for subsistence agriculture has caused continuous loss of large mammal ranges for 45 years (Cumming & Lynam 1997).

The natural land cover corresponds to the Guinea-Congolian forest vegetation (Hawthorne & Musah 1993, Hall & Swaine 1981). At the north, the vegetation is dry semi-deciduous, however, more southwards, the vegetation changes to the moist semi-deciduous vegetation type (Hall & Swaine 1981). This matches with Taylor's (1960) *Celtis zenkeri-Triplochiton scleroxylon* association. Key commercial species of these forests are: *Triplochiton scleroxylon*, *Entandophragma utile*, *E. cylinderium* with the climbing palms *Ancistrophyllum secundiflorum* and *Calamus deerratus* being characteristic of swampy areas. The mean elevation is 200–550 m, with generally undulating topography. Mean annual rainfall is 680–1 450 mm/year, characterized by a bi-modal wet season from March to July and September to November, and a major dry season from December to February.

2.2 Synthesis of secondary information

Scientific literature and project reports relating to elephant distribution and abundance and those dealing with socio-economic information on communities conducted in western Ghana, particularly those papers produced under the *Protected Area*

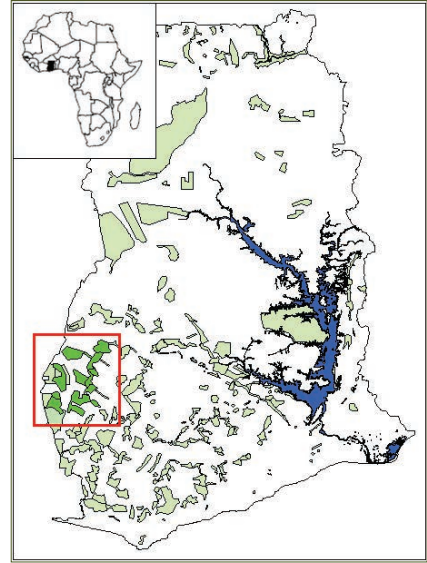


Figure 1: Location of the BGFB (red square) in western Ghana with respect to Africa

Development Project (PADP) Phases I & II were consulted. Other related literature on elephant activities, including elephant crop damage reports, was examined and relevant information extracted. Secondary spatial and temporal data on land-use types and human demography of the study area was obtained from the appropriate institutions and scientific literature. Current information including map zonation and functioning of the Bia Biosphere Reserve and other reference material on the biosphere reserve concept was obtained from the GHANAMAB Secretariat (EPA Head Office) and the Wildlife Division. Furthermore, papers produced under CARE International's *Community Forest Biodiversity Project* in the Western Region of Ghana were consulted, more especially those relating to habitat assessment of CREMAs and those dealing with socio-economic information on communities.

2.3 Determination of corridor creation potential

2.3.1 Geographical feasibility

The use of shelterbelts by elephants in the BGFB (Parren & Sam 2003) indicates that designing forest corridors within CREMAs have the potential to be used as passages by elephants. Thus, the feasibility of CREMAs as forest corridors between reserves was determined based on the analysis of satellite images and maps. These included the following aspects: an examination of the locations of the CREMAs with respect to elephant distribution; presence of rivers and streams to aid in reforestation; as well as land use and remaining forest cover.

2.3.2 Socio-economic feasibility

Potential CREMA corridors were influenced by, among other things, the attitudes of the local people. A questionnaire (Appendix 1) was developed and administered in CREMA communities (Plates 1 and 2). Issues noted included the local perceptions towards the possible establishment of elephant corridors within CREMAs. Community perception was broadly classified as follows: importance of elephants; benefits derived from elephants; willingness to improve corridor condition through tree planting; and management of human elephant conflicts (co-existence).



Plate 1: Focused group discussion at Bianco on local perceptions towards the possible establishment of elephant corridors within the Elluokrom CREMA



Plate 2: Focused group discussion at Aberewakrom on major human-elephant conflict areas within the Kwamebikrom CREMA

The level (percentage) of positive response derived for a particular perception in a CREMA area (potential corridor) was quantified on a four-point scale of relative importance. Below 25% of importance of a particular perception in a community was considered very low, hence less likely to support elephant corridors and was awarded one point. 25% to 50% of importance was considered low and awarded two points. 50% to 75% of importance was considered average and awarded three points. More than 75% of importance was considered high, hence most likely to support elephant corridors and awarded a full mark of four points. Feasibility of supporting elephant corridors was based on a corridor priority setting and an average priority rank derived from the total awarded points in a CREMA community.

3. Results

3.1 *Elephant distribution and movement pattern in BGFB*

The elephant population in the BGFB is fragmented and isolated into the Bia and Goaso populations. Currently, there is no movement of elephants between the two populations or any sign of elephant movement across the Ghana — Cote d'Ivoire border.

3.1.1 Bia Area

The largest elephant population in western Ghana is confined to the forests of southern BGFB. Based on current literature and contacts with farmers and staff of the Wildlife Division it is concluded that elephant density is concentrated in the Bia Biosphere Reserve (BBR). Sam and others (2006) in Blanc and co-authors (2007) provide an estimate of 115 elephants for the BBR. All the other forest reserves (FR) in the Bia area showed very little evidence of elephant presence. Though Blanc and others (2007) compiled reports of evidence of elephants in the centrally located Bia North FR and the more southern placed Dadieso FR, there was no evidence in the current study to support their records.

Much evidence of elephant crop raiding activities was recorded in the environs of the BBR during the fieldwork. Elephant presence was confirmed based on their regular visits to farms in certain times of the year, specifically in the wet season when food crops mature.

3.1.2 Goaso area

The only surviving elephant population in the Goaso area is that of Mpameso FR. Sam (2004) provided an estimate of 72 elephants for the Mpameso area in northern BGFB. Apart from evidence of an occasional elephant movement from Mpameso FR via the Bia shelterbelt (SB) to the Bia Tano FR, there were no other signs of elephant activity in the other forest reserves that constitute the Goaso range (Danquah *et al.* 2009). A few reports of elephant crop raiding were noted in the northern portions of Mpameso FR in the area that joined the Bia SB.

The Goaso home range includes four shelterbelts: the Bia and Amama SBs, connecting two forest reserves each, and the Goa and Abonyere SBs which are connected only at one side to a forest reserve. Elephants visit Abonyere but the elephants do not

move further than 4–5 km into the shelterbelt, while in Goa SB no elephant presence is reported. Elephants also occasionally use the Bia SB to move from the Mpameso FR into Bia Tano and Asukese FRs. A few elephant trails and droppings were observed along the length of the shelterbelt, confirming BP Conservation Awards (2003) and Dickinson's (1990) observation of the same movements in earlier years.

3.2 Review of corridor studies

Several proposals have been made with regards to the feasibility of corridors in the Bia-Goaso-Diambarakrou Wildlife Corridor between western Ghana and eastern Cote D'Ivoire (Sebogo & Barnes 2003). Notable among these proposals are works by Versteegen (1993) in Ivory Coast; De Leede (1994) in Ghana and subsequently work by Parren and others (2002), Parren and Sam (2003) and BP Conservation Awards (2003) in both countries.

De Leede (1994) observed that the geographical as well as the socio-economic feasibility of corridors between the Bia and the Goaso population appeared to be very low as:

- (a) Several forest reserves have been converted into farmlands in recent years (Bia Tawya, Sukusuku) resulting in a general decreased elephant habitat;
- (b) The areas in between remaining reserves are intensively used for agriculture and elephant populations were more isolated than thought of before;
- (c) A lot of villages are scattered throughout this agricultural area;
- (d) There is little off-reserve forest left to be used as a starting point for the creation of corridors;
- (e) General negative attitude of local communities regarding elephant conservation and reforestation.

Versteegen (1993) observed that in the future, if the survival of these elephant populations is to be assured, efforts have to be made to connect the elephant populations in Ghana with those in Cote d'Ivoire. This can only be done by establishing a corridor along the Bia River and a corridor from Bia Biosphere Reserve via Diambarakou to Bossemattie, which will imply a major reforestation programme in co-operation with the riverine population. In review of the above and works by De Leede (1994); Parren *et al.* (2002); Parren and Sam (2003) and BP Conservation Awards (2003), the three most feasible elephant corridors are proposed (Figure 2), of which two (A and B) are transfrontier:

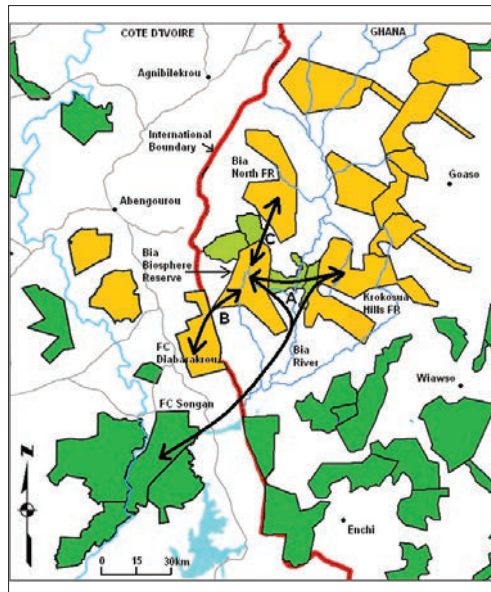


Figure 2: The Bia-Goaso-Diambarakrou Wildlife Corridor showing location of CREMAs (light green), BBR and other confirmed elephant ranges (yellow) in western Ghana and eastern Cote d'Ivoire. The arrows indicate proposed feasible corridors linking BBR to other reserves

- A. Bia River corridor –To connect the population of the Bia Biosphere Reserve with that of the FC Songan area in Cote d’Ivoire along the Bia River, including the Dadieso FR which contains a small elephant population (Blanc *et al.* 2007). A forest corridor along the Bia River would connect the Bia Biosphere Reserve with the Boin River FR and the FC Songan with the Bia Biosphere Reserve and the Boin River FR through the Dadieso FR. At the same time it would link the Bia population with the Goaso population through the Krokosua Hills FR that almost touches the Bia riverbanks. However, it is not clear whether elephants can cross the hilly terrain of Krokosua Hills and Bonsam Bepo FRs into the northern Goaso area if a corridor was created.
- B. Diambarakrou Corridor— FC Diambarakrou offers an interesting option for corridor establishment between Cote d’Ivoire and the extreme western tip of Bia Biosphere Reserve in Ghana. Firstly, because half this distance covers reserved forest area. Secondly, the potential corridor could follow a stream that flows from FC Diambarakrou to FC Songan where the local human population is sparse (Parren & Sam 2003).
- C. Bia Biosphere Reserve to Bia North FR— A corridor between Bia Biosphere Reserve and Bia North is also feasible in terms of distance (about 4 km long). Re-introduction of elephants into the Bia North FR from Bia Biosphere Reserve makes it an interesting corridor option to explore, however there are no major rivers or streams linking the two reserves to facilitate the creation of a corridor.

3.3 Geographic feasibility

The BGFB includes four CREMAs: the Kwamebikrom, Asuopri, Asempaneye and Elluokrom CREMAs (Figure 3). The Kwamebikrom and Asuopri CREMAs are conveniently positioned to connect the Bia Biosphere Reserve to the Bia North FR, whilst the Asempaneye and Elluokrom CREMAs are naturally aligned to connect Krokosua Hills FR to BBR. Currently, elephants occasionally visit the Kwamebikrom, Asuopri and Elluokrom CREMAs to raid crops but the elephants do not move further than 1–2 km into the CREMAs. However, no elephant presence has been currently reported in the Asempaneye CREMA.

3.4 Status of vegetation of CREMAs

The land cover of all the CREMA clusters is quite heterogeneous ranging from built up area to pockets of undisturbed forest. In the Kwamebikrom CREMA (Figure 4), the land cover is comprised of an appreciable percentage (about 30%) of open and closed vegetation (forest) type. This is predominantly cocoa agro-forestry systems where cocoa is grown under varying intensities of shade trees. Shade tree cover is most dense towards the south-eastern section of the CREMA that borders the BBR. Specific stool lands that are found in this area are King Solomon, Aberewakrom and New Wenchi. Other areas included the Kwamebikrom and E. K. Manu stool lands.

In the Elluokrom CREMA (Figure 5), degraded and built-up areas dominate the area. This is mostly farmlands and degraded forest. The farmlands are also in turn

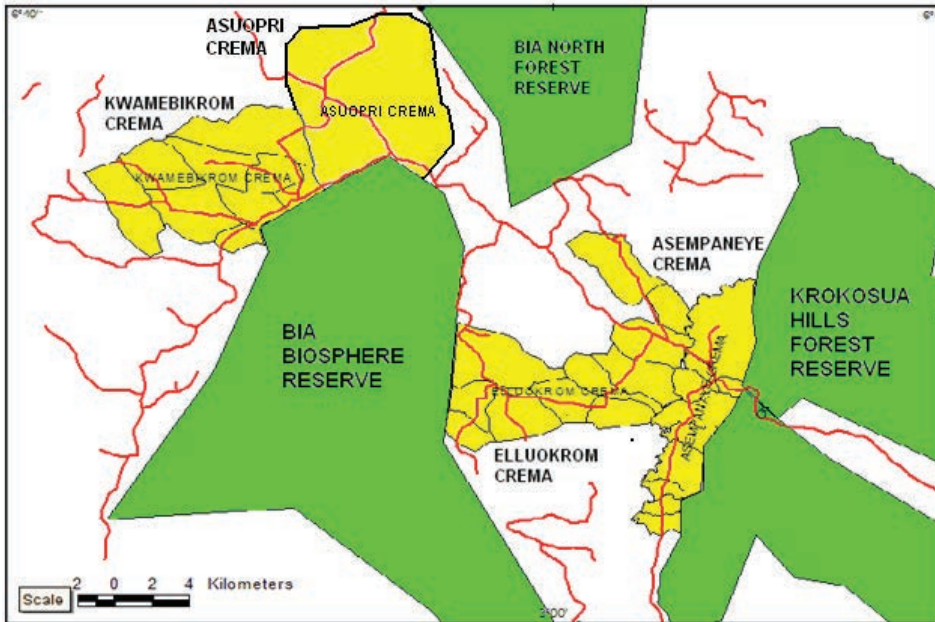


Figure 3: Location of the CREMAs (yellow) around the Bia Biosphere Reserve

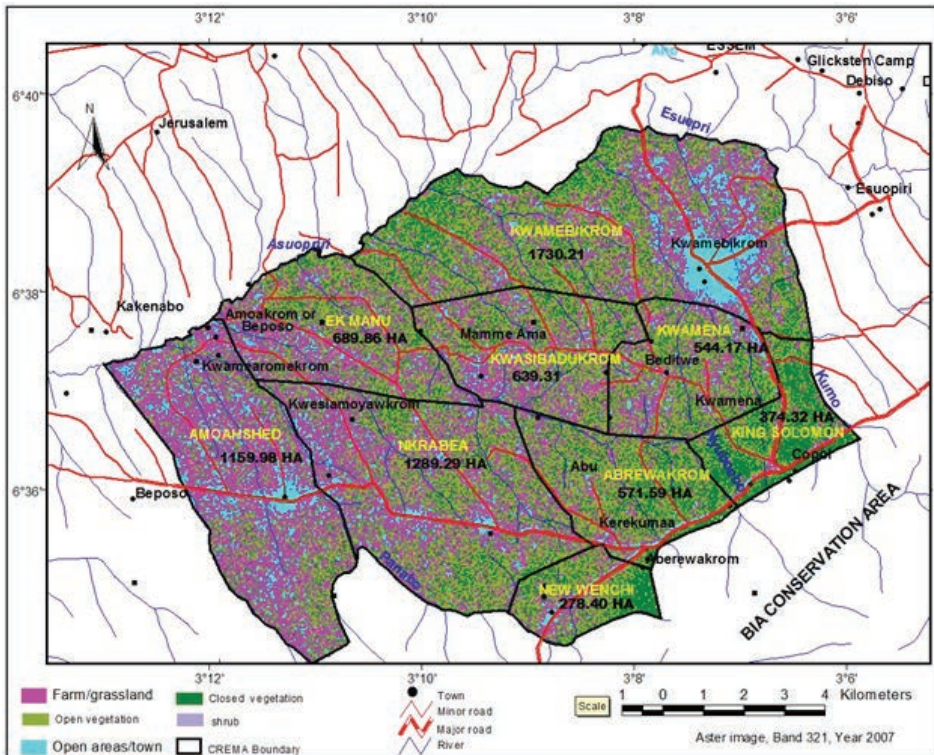


Figure 4: Land cover map of Kwamebikrom CREMA. Total area = 7 277.13 ha

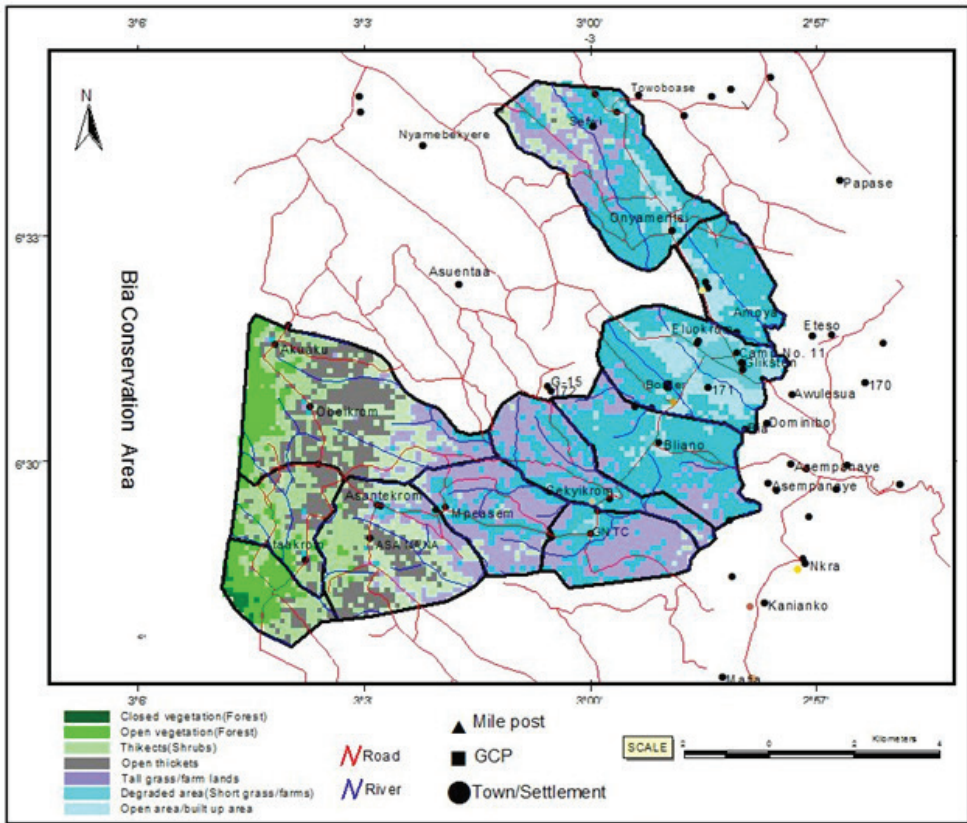


Figure 5: Land cover map of Elluokrom CREMA. Total area = 7 950.00 ha

dominated by cocoa agriculture. The most abundant tree cover type is cocoa. The extent of cover in cocoa farms varies from closed canopy cocoa (cover almost 100%) to open types with cassava and other food crops. Forest tree cover is most dense towards the western section of the CREMA that borders the BBR. Specific stool lands that are found in this area are Akuoko, Obeikrom and Attakrom which still have a good representation of forest patches.

The Elluokrom CREMA has a dense network of water resources. The major river that flows through it is the Bia River in a north-south direction. It flows very close to major communities like Elluokrom and Bianco towards the south of the CREMA. Along some sections of the Bia River and its tributaries are dense bamboo and rafia vegetation which in some areas cover the surface. That renders sections of the river not visible. What is apparent is a distinct forest cover meandering through cocoa within the CREMA. Whilst most of the tributaries are temporal, few are perennial and are a major source of drinking water for most of the communities. The commonest threat to these water resources are the agricultural activities that take place very close to the buffer. In addition to farming some localized fishing activity were observed in a few areas along the Bia River in the CREMA.

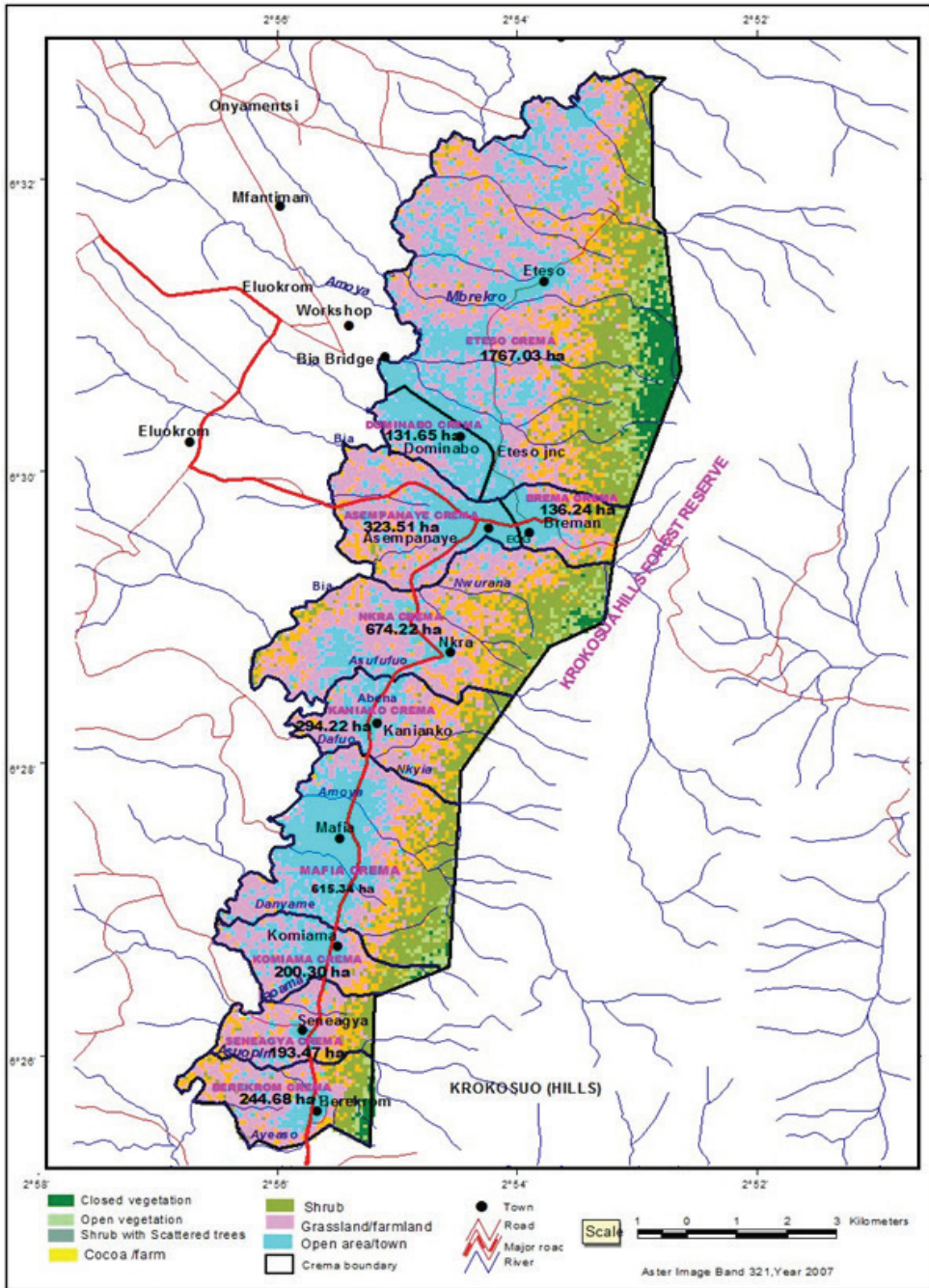


Figure 6: Land cover map of Asempaneye CREMA. Total area = 4 580.66 ha

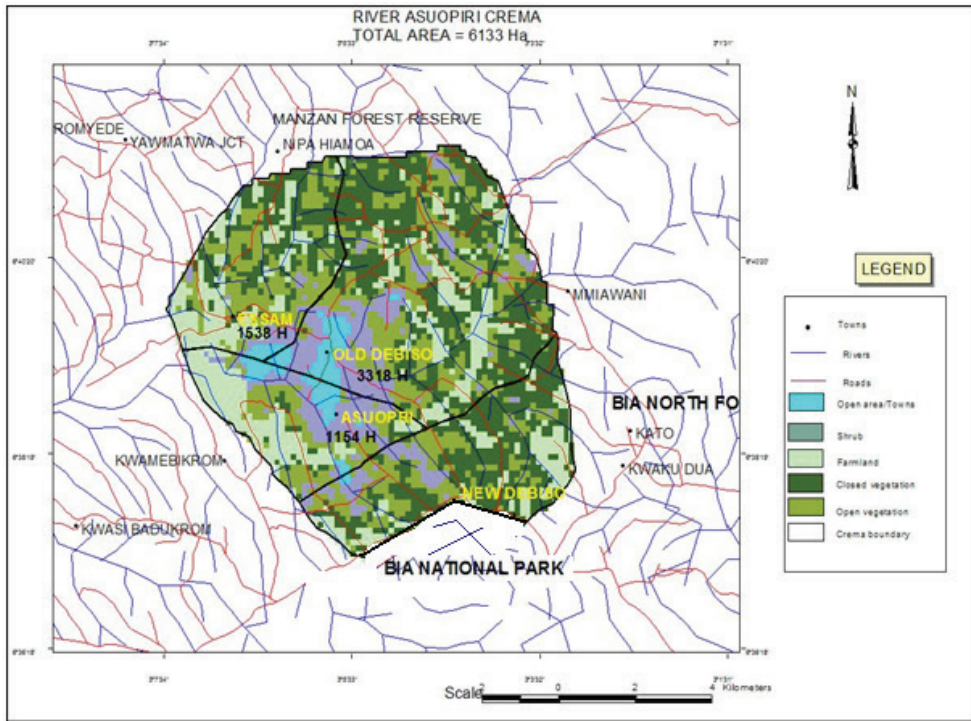


Figure 7: Land cover map of Asempanye CREMA. Total area = 6 133.00 ha

Of all the CREMA clusters, the Asempanye cluster has the biggest built-up area which is mainly settlement and open farmland (Figure 6). However, towards the eastern corridor with the Krokosua Hills FR is a stretch of open forests that end in pockets of closed forests. There is also a feeder road that runs for nearly 60% of the entire length of the CREMA.

The land cover of the Asuopri CREMA is comprised of a substantial percentage (about 40%) of open and closed vegetation (forest) type (Figure 7). This is also predominantly cocoa agro-forestry systems where cocoa is grown under varying intensities of shade trees. Forest vegetation is most dense towards the northern, eastern and southern sections of the CREMA that borders the Manzan FR, Bia North FR and BBR. Specific stool lands that are found in these areas are Old Debiso and New Debiso.

3.5 Socio-economic feasibility

One hundred individuals were arbitrarily drawn from ten randomly selected CREMA communities and interviewed. The major land use practice was farming and most (62%) community members had been actively involved in CREMA activities including tree planting exercises as a way of improving the forest condition (Plate 3). Hence, there was a general level of awareness concerning the conservation of wildlife and protection of forest resources especially in off-reserve areas. The general opinion among most communities (68%) was the continuous protection of elephants because they represented a national heritage to be preserved for future generations and also their existence was important for the survival of other wildlife (Table 1).



Plate 3: Locally nursed seedlings at Kwamebikrom to be used to improve forest conditions in the Kwamebikrom CREMA.

Table 1: Priority ranking (percentage) on community support for elephant corridors in CREMAs

Corridor	A	B	C
Rank for importance of elephants	4 (87)	4 (82)	4 (79)
Rank for benefits from elephants	3 (62)	2 (38)	3 (57)
Rank for improving forest conditions	4 (100)	4 (100)	4 (100)
Rank for managing crop raids	2 (26)	1 (11)	2 (44)
Average priority rank	3.3	2.8	3.3
Corridor priority settings*	High	Medium	High

*Corridor priority settings

- 1 High = Average priority rank 3.0–3.9. Most likely to support elephant corridors.
- 2 Medium = Average priority rank 2.0–2.9. Likely to support elephant corridors.
- 3 Low = Average priority rank 1.0–1.9. Less likely to support elephant corridors.

4. Discussion

4.1 Status of elephants

Elephants were known to inhabit all the reserves in the study area in considerable densities (De Leede 1994), hence, one would have expected a much higher population and wider distribution than currently found; however, the present situation on the ground is less favourable. Results indicate that elephant density and distribution have reduced significantly in the Goaso area (Sam *et al.* 2006). This contra-indication to De Leede’s

work is important as it is two decades ago since their study was conducted. With such a drastic decline in elephant numbers over the period, concerted efforts should be put into investigating the causes, and steps taken quickly to address them.

Existing studies (Sam 2004, Sam *et al.* 2006, Blanc *et al.* 2007) show that the BBR shelters a far more important elephant population than the Mpameso FR. Ranking second in forest elephant density in Ghana, after the Kakum Conservation Area (Blanc *et al.* 2007), the Bia elephant population is very significant for elephant conservation and long-term survival in West Africa. Such a reasonably high concentration of elephants in a relatively small area also has management implications for tourist attraction and especially for elephant viewing. A rather complex attribute that regularly affects local community relations is the associated elephant crop depredations. Some locally affected communities have in the past protested and organized experienced elephant hunters, purportedly from the Goaso area, to track and shoot offending elephants in the view of scaring other potential crop raiders from the area. The Wildlife Division is currently managing the situation through its community outreach team, which regularly meets with opinion leaders and affected communities to amicably deal with the problem. Though the Goaso population may fall far below in elephant density in the general sub-regional context, the fact that the Goaso area has attained a level of protection status under the Forestry Commission means that the elephants are currently more secured than ever, creating the right conditions and possibilities for growth. In the Ghanaian context too, its importance cannot be over emphasized, especially taking into consideration the number of forest populations available. What's more, the Goaso elephant population far exceeds the mean size of 40 individuals set in West Africa in its elephant strategy (Sebogo & Barnes 2003) and has a crucial role to play in ensuring the long-term survival of the Bia population.

4.2 Potential of CREMAs as elephant corridors

The CREMA concept is based on the establishment of areas where wildlife management is incorporated into existing land use. CREMAs confer increased local control and participation in natural resource (especially wildlife) management, increase the scope for farmer rights over trees, and provide a facilitating platform to sort out land tenure issues. If farmers realize financial benefits from natural resources, they will look after them. While the CREMA programme has focused on wildlife resources, the implementation of this programme will have long-term significant and positive implications for a wide range of resources other than wildlife.

Reconnecting habitat fragments to nearby forest reserves is one of the most effective management strategies for ensuring the long-term survival of fauna in fragmented landscapes. Linking two patches of isolated elephant habitat for instance, allows elephants to access a wider range of resources, especially if some resources are available only at certain seasons. From this, an initial BBR — Krokosua Hills FR corridor, linking the Bia population with that of Goaso seems most practical. This could form the initial steps into creating the Bia River corridor (De Leede 1994, Parren *et al.* 2002, Parren & Sam 2003) that will ultimately link the Bia with the Boin elephant population and the

Songan in Cote d'Ivoire with the Bia and the Boin populations. A BBR–Bia North FR (De Leede 1994, Parren *et al.* 2002, Parren & Sam 2003) corridor seems the next practical corridor option to explore and this is intended to reintroduce elephants into the Bia North FR from BBR (Danquah *et al.* 2009).

Both intra-reserve corridor options are interesting because they intend to increase elephant range of the BBR, which holds a major elephant population in the area. Major advantages are that both corridors lead through established CREMAs, and are adjacent to the northern, best preserved part of the BBR. Also, the Elluokrom CREMA that cuts across inundated areas and riverbanks, such as the Bia River, has an additional advantage of providing constant drinking water for the elephants. Artificial waterholes could be created in the other CREMAs to ensure that elephants stay within their boundaries. This has been successfully done inside Forêt Classée (FC) de Bossematié (Waitkuwait 1992). The distribution of elephants along rivers, especially in the dry season, is well-documented (Danquah *et al.* 2001, Sam *et al.* 1997) and in most cases, scarcity of water in the range and elephants' affinity to water becomes the central theme for such distribution.

The Wildlife Division also integrated this corridor idea into the most recent management plans for the communities. Increase in forest cover in corridors is feasible because local people, through the greening Ghana initiative, are currently favouring forest development in the CREMAs and the fact that farmers are eager to plant trees along riverbanks is an important aspect when considering the creation of corridors. A later effort to further repopulate these forests with elephants can be reached by linking them with nearby FC Songan in Cote d'Ivoire and FC Diambarakrou along the river Bia.

5. Conclusions

Corridors can provide more services than just conservation of biodiversity. Corridors can also be beneficial in terms of the water level and water quality to farmers along the Bia River, and produce useful non-timber forest products. The latter could form the key to local participation in forest restoration, and wildlife management and monitoring such as developed by the CREMA programme. The concept of achieving a sustainable balance between conserving biological diversity and promoting economic development is also supported by key components in the objectives of the UNESCO's Man and the Biosphere (MAB) Programme.

The Biosphere Reserve and CREMA concepts are very appropriate for corridor designs, since it empowers local communities in resource utilization and opts for its sustainable use. Corridor creation deals with the rural landscape and touches upon the preservation of existing forest fragments in a wider zone than the corridor, as well as the sustainability of farming by integrating more tree components in agricultural practices in the corridor's buffer zone, next to the reforestation of degraded areas within the planned corridor zone (Smeding & Joenje 1999).

However, to ensure that elephants will use these corridors, we have to ensure that human intervention in the corridor zone is well regulated with restrictions in time and space for human activities. The biggest human-elephant problem might be formed by

the elephant's crop raiding activities. A community-based, low-tech approach to deter elephants from raiding agricultural fields in the corridor's transition zone (Osborn & Parker 2003) seems to be the most sustainable solution to mitigate the direct costs involved in loss of primary food and cash resources, and the indirect ones through a variety of social costs that can even lead to a complete failure of corridors functioning as a way of passage (Parren & Sam 2003).

6. Recommendations

The corridors proposed here would require a number of actions and guidelines in order to further increase their likelihood of use as a wildlife corridor. In the first place, forest elephants cherish certain fruit trees including *Parinari excelsa*, *Balanites wilsoniana*, *Panda oleosa*, *Sacoglottis gabonensis* and *Tieghemella heckelii* (Martin 1991, Hawthorne & Parren 2000, Theuerkauf *et al.* 2001). Planting these trees in designated corridors within CREMAs, or enriching forests close to the entrance of these forest corridors could attract elephants and increase the chance that they use these CREMAs. Further research should consider species composition, structure and functions of the trees to be considered for enrichment planting. The trees should also serve as a source of attraction to other fauna and benefit local livelihoods.

Secondly, there is the need to establish intensively managed wildlife refuges within the CREMAs, where absolutely no human activity occurs. Riverine vegetation, swamps, sacred grooves and habitat around ponds and rivers should be given precedence because of the high biodiversity that exists in those places and the unattractive farming and hunting prospects associated with them. Such refuges, when identified, need to be expanded and linked-up in order to safeguard their integrity and should be given priority in tree planting exercises. Creating and subsequently expanding intensively managed refuges within CREMAs forms the basis of establishing internal wildlife corridors within the larger CREMA and is an effective way of curtailing unregulated hunting and forest clearing activities, whilst improving habitat to encourage wildlife and elephant usage.

Thirdly, changes in land use are recommended to conserve the remaining forest patches in the CREMAs. Agricultural planning and techniques need improvement in the area to feed an increasing human population faced with deteriorating natural conditions and to reduce the vulnerability of their wildlife habitat conversion to farmlands. Farmers should be encouraged to leave forest patches on the farms, or farm not too far from the villages. They should also farm close to each other to reduce the surface-area ratio. In part, achieving this aim will depend upon improving the intensity and effectiveness of community sensitization and conservation education.

Lastly, the long-term viability of CREMAs depends on earning the goodwill of all community members. Communities may need to be creative in their attempt to control hunting activities in their respective CREMAs because some community members have come to rely upon these off-reserve areas for economic activities, especially non-timber forest products gathering. Full government backing at the local and national level for

this type of effort would ensure its success. Alternative protein and income sources (e.g. fish breeding and bee keeping) should be developed in the local communities to help reduce the over reliance on bush meat and land for farming.

7. Acknowledgements

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Appendix I

Questionnaire on local perceptions towards the possible establishment of elephant corridors within CREMAs in selected fringe communities in the Bia-Goaso area.

Personal information

- 1 Community Age
Occupation Sex
- 2 Are you a native of this village? Yes No
- 3 If farmer, how many farms do you have and what are the sizes?
.
- 4 How far is your farm from the CREMA?
1 km 1–2 km 3–5 km 6–8 km
- 5 In what way has the CREMA affected your farming?
.
- 6 If hunter, what animals do you hunt?
.
- 7 How far do you hunt from the CREMA?
1 km 1–2 km 3–5 km 6–8 km
- 8 In what way has the CREMA affected your hunting?.
.

Land-use practices

- 9 What benefit does your community derive from the CREMA?
.
- 10 What are the land use practices in the CREMA?
.
- 11 What have you observed about forests in CREMA?
increase reduce no idea
- 12 If reduced, what is the cause?
.
- 13 Can something be done to improve the situation? Yes No
- 14 If Yes, what?
.

Importance of elephants

- 15 Have you observed any elephants in the CREMA before? Yes No
- 16 If Yes, give date(s)
season(s).

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place(s)
 direction of movement.

- 17 If No, did someone talk about elephants passing here some time ago? Yes No
- 18 Do you think elephants and wild animals should be protected / important?
 Yes No
- 19 If Yes, why?
 bush meat heritage tourism ecosystem function others
- 20 Other benefits community derive from elephants?

- 21 Is Human–Elephant Conflict serious in your area? Yes No
- 22 If Yes, what form does it take?
 crop raids human injury well raids others
- 23 Which crop(s) are usually raided?

- 24 Do you employ any elephant deterrent method on your farm? Yes No
- 25 If Yes, give name(s).
- 26 Are the methods effective? Yes No
- 27 Do you need help to drive the elephants away? Yes No
- 28 Do you think humans and elephants can co-exist with proper management?
Yes No
- 29 If Yes, how?

- 30 If No, would you like to relocate and be compensated? Yes No
- 31 Have you ever been engaged in a tree planting exercise before? Yes No
- 32 Would you like to do it again to improve elephant habitat? Yes No
- 33 If Yes, why.
- 34 If No, why?
- 35 Can you sacrifice part of your land to create elephant corridors? Yes No
- 36 If No, give reasons

14



Fish Farming Enterprise as a Catalyst to Environmental Conservation: Case of Mount Kenya Man and Biosphere Reserve

L'entreprise d'élevage piscicole comme catalyseur de la conservation environnementale: Le cas de la réserve Homme et biosphère du Mont Kenya

FRED KIHARA¹ • NANCY CHEGE² • GAVIN HOCH³

Abstract

At 5 199 m above sea level, Mount Kenya is the second highest mountain in Africa (Photo 1). The ecosystem is home to a diverse variety of plant and animal life, including numerous endemic species of plants as well as rare and endangered fauna species. As a result of its impressive landscapes, outstanding natural processes and its capacity to support human development, Mt. Kenya was listed as a UNESCO Man and Biosphere Reserve (MAB) in 1978. However, in recent decades the Mt. Kenya Man and Biosphere Reserve has experienced considerable environmental pressure and degradation as a result of poor resource management, population pressure, poverty, and increased dependence on forest resources. These factors have led to shrinking forests, drying up of streams, soil erosion, reduced species diversity and general decline in the capacity of the forest to provide economic and environmental services for nearby communities (CMTS 2001, Gathaara 1999, Wass 1995). These effects have, in turn, negatively impacted the pace and uniformity of human development activities around the Mt. Kenya Man and Biosphere Reserve.

The Community Management of Protected Areas Conservation (COMPACT) Initiative, supported by the Global Environment Facility (GEF) through the Small Grants Programme (SGP) and implemented by the United Nations Development

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Programme (UNDP), seeks to reverse these trends by engaging communities in environmental conservation projects around protected areas and World Heritage Sites (WHS) such as Mt. Kenya (UNESCO 1997). Fish farming enterprises are some of the most successful examples of community-based projects that have promoted environmental conservation while also improving livelihoods (Bovarnick & Gupta 2003, Brown *et al.* 2005, Liniger *et al.* 2011). Beginning in 2004, COMPACT has supported five community-based fish farming enterprises around the Mt. Kenya Man and Biosphere Reserve (Photo 2). As a result of the success of these pilot projects, many other community groups have started fish farming enterprises to generate income and help conserve the environment within and around their communities. Other stakeholders, including Government of Kenya (GoK) ministries and District Fisheries offices, local and international non-governmental organizations (NGOs), donor organizations and local administration officials have also recognized the numerous livelihood and conservation benefits of fish farming projects, and have joined in developing and supporting these community enterprises within the Mt. Kenya Man and Biosphere Reserve and in other suitable areas across the nation (Ngugi *et al.* 2007).

Keywords: GEF, Small Grants Programme, World Heritage Site, income, sustainable, tilapia, trout, tree seedling, nursery, forest, water catchment, soil erosion, firewood

Résumé

Situé à 5,199 m au-dessus du niveau de la mer, le Mont Kenya est la deuxième montagne la plus haute en Afrique (Photo 1). L'écosystème accueille une variété diversifiée de flore et de faune dont certaines espèces végétales endémiques ainsi que des espèces animales rares et menacées d'extinction. Grâce à ses paysages impressionnants, ses formations naturelles époustouflantes et sa capacité à soutenir le développement humain, le Mt Kenya a été classé réserve Homme et Biosphère (MAB) par l'UNESCO en 1978. Cependant, au cours des récentes décennies, la réserve Homme et Biosphère du Mt Kenya a été soumise à une pression considérable et à une dégradation en résultat d'une gestion médiocre des ressources, de la pression des populations, la pauvreté et une dépendance plus accrue des ressources forestières. Ces facteurs ont engendré l'amenuisement des forêts, l'assèchement des cours d'eau, l'érosion du sol, la réduction de la diversité des espèces et le déclin général de la capacité de la forêt à fournir des services économiques et environnementaux aux communautés voisines (CMTS 2001, Gathaara 1999, Wass 1995). A leur tour, ces effets ont eu un impact sur le rythme et l'uniformité des activités de développement humain aux alentours de la réserve Homme et Biosphère du Mt Kenya.

L'initiative de Gestion communautaire pour la conservation des zones protégées (COMPACT) soutenue par le GEF (Global Environment Facility) grâce au Programme de petites subventions (SGP) et mis en place par le Programme des Nations Unies pour le développement (PNUD) entend renverser ces tendances en engageant les communautés dans des projets de conservation environnementale autour des zones

protégées et des sites du patrimoine mondial (WHS) comme le Mt Kenya (UNESCO 1997). Les entreprises d'élevage piscicole se placent parmi les exemples de réussite des projets communautaires ayant encouragé la conservation environnementale tout en améliorant les moyens de subsistance (Bovarnick & Gupta 2003, Brown et al. 2005, Liniger et al. 2011). Depuis le début 2004, COMPACT a soutenu cinq entreprises d'élevage piscicole gérées par la communauté autour de la réserve Homme et Biosphère du Mt Kenya (Photo 2). En conséquence du succès de ces projets-pilotes, de nombreux autres groupes communautaires ont lancé des entreprises d'élevage piscicole pour générer des revenus et contribuer à préserver l'environnement au sein et autour de leurs communautés. D'autres intervenants y compris les ministères et bureaux des pêcheries régionales du Gouvernement du Kenya (GoK), les organisations non gouvernementales (ONG) locales et internationales, les organismes de bailleurs de fonds et les fonctionnaires des administrations locales ont également reconnu les nombreux avantages de l'élevage piscicole en matière de subsistance et de conservation et se sont joints pour développer et soutenir ces entreprises communautaires dans la réserve Homme et Biosphère du Mt Kenya ainsi que d'autres zones correspondantes au sein de la nation (Ngugi et al. 2007).

Mots-clés: GEF, Programme de petites subventions, site du patrimoine mondial, revenu, durable, tilapia, truite, jeunes plants d'arbres, pépinière, forêt, bassin hydrographique, érosion du sol, bois de combustible



Photo 1: Mt. Kenya Man & Biosphere Reserve in the Central Highlands of Kenya



Photo 2: COMPACT-supported community aquaculture enterprise in eastern Mt. Kenya

I. Introduction

Mt. Kenya is the highest mountain in the nation of Kenya and the second highest mountain in all of Africa, second only to Mt. Kilimanjaro in neighboring Tanzania. With its rugged glacier-clad summits and forested middle slopes, Mt. Kenya is one of the most impressive landscapes in East Africa. The evolution and ecology of its afro-alpine flora

provide an outstanding example of ecological processes. Mt. Kenya is home to a diverse variety of flora and fauna, including rare species such as the Mountain Bongo antelope, Giant Lobelia, and Groundsel Cabbage (Photo 3) (Gathaara 1999, GEF-SGP 2010, KWS 2002). Other wildlife such as elephants, zebras, lions, leopards, buffalo, antelopes and monkeys and plant species such as the acacia, podo and bamboo also form an integral part of the mountain and forest ecosystem (ICRAF 1992). Volcanic sediment in the surrounding region's soil and the huge volume of fresh water coming down the slopes make the area particularly favourable for plants, wildlife and human agricultural activities. As a result of its wealth in natural resources, human populations have lived near the mountain for centuries. However, within the last half century, human populations and dependence upon Mt. Kenya's natural resources have increased significantly (CMTS 2001, Gathaara 1999, KWS 2002).

In order to protect the mountain and the surrounding area, Mt. Kenya was gazetted as a national park in 1949. The gazetted area was later expanded to include part of the forest reserve which encircles it, mostly above the 3 000 m contour line (GEF-SGP 2010). As a result of its impressive landscapes, outstanding natural processes and its capacity to support human development, Mt. Kenya was designated as a UNESCO Man and Biosphere Reserve in 1978. This designation helped begin raising awareness among communities living around the mountain of the importance of the natural environment and its resources to the larger Mt. Kenya ecosystem and the human populations living near the mountain. The combined area of the national park and the forest reserve (1 420 square kilometers) was also listed as a UNESCO World Heritage Site in 1997 (UNESCO 1997). The Kenya Wildlife Service (KWS) and the Forest Department share management of the Mt. Kenya ecosystem through a joint integrated management plan (KWS 2002).

Despite these protections, the Mt. Kenya ecosystem has been substantially degraded in recent decades as a result of poor resource management, population pressure and dependence upon forest resources. These factors, combined with lack of employment, poverty and ease of access to the forest, have led to over-abstraction of natural resources by communities living near the mountain ecosystem as the primary means of sustaining their livelihoods. Large areas of the Mt. Kenya forest have been thinned or destroyed to supply timber for use as household fuel wood and for construction purposes. Indigenous forest and riparian areas have also



Photo 3: The Mt. Kenya Man & Biosphere Reserve is home to rare flora such as the Giant Lobelia and Groundsel Cabbage.

been cleared to make room for agricultural production (Photo 4). In order to sustain agricultural production, rivers and streams have been over-abstracted. These activities have led to the drying up of streams, reduced water volumes from rivers originating from the forest, soil erosion, reduced species diversity, and a general decline in the capacity of the forest to provide economic and environmental services (CMTS 2001, Gathaara 1999, KWS 2002, Wass 1995). This environmental degradation continued up to around year 2000, when a remarkable decline in degradation was noted, as evidenced by aerial surveys and ground patrols (CMTS 2001).



Photo 4: Riparian area cleared for agricultural production

In an effort to mitigate the environmental degradation and address the causes of this degradation at the Mt. Kenya WHS, the COMPACT Initiative was formed in March 2000, after rounds of consultations with a wide range of institutions, such as KWS, Forest Department (FD), USAID, UNDP, and Centre for Integrated Research and Training in Arid and Semi-Arid Lands (CETRAD) amongst others (CMTS 2001). The initiative, which also operates in seven other natural World Heritage Sites across the world, promotes community-based conservation and management in and around the sites. COMPACT offers financial and technical assistance directly to community-based groups and projects that serve to improve livelihoods while addressing the threats which jeopardize ecological integrity in globally important protected areas (GEF-SGP 2010).

The COMPACT programme in Kenya is focused on the Mt. Kenya World Heritage Site and Man and Biosphere Reserve (GEF-SGP 2010). It is implemented under the framework and grant-making mechanism of the GEF Small Grants Programme of UNDP. Significant operational support is also provided by the United Nations Foundation (UNF), which provided the start-up funds to establish COMPACT. GEF-SGP is operational in 122 countries and has, since 1992, provided support to community initiatives that help protect the global environment, mainly by linking environmental issues to livelihood concerns. SGP, which is implemented by the UNDP on behalf of the other GEF agencies, channels funds to communities through community-based organizations (CBOs) and local NGOs to address five critical threats to the global environment which include the following (GEF-SGP 2010):

- Biodiversity loss;
- Climate change;
- Degradation of international waters;
- Land degradation;
- Persistent organic pollutants.

Since the initiation of the Mt. Kenya COMPACT Initiative in 2001, the project has partnered with more than 70 community groups, NGOs, and other stakeholders in the implementation of environmental conservation and livelihood improvement projects (GEF-SGP 2010). COMPACT will continue to support community-based environmental conservation projects in the forthcoming GEF Phase V which runs from years 2011 to 2014.

2. Background on community fish farming at the Mt. Kenya Man and Biosphere Reserve

Fish farming, or aquaculture, is the practice of rearing fish in a controlled environment such as a pond or tank, until the fish reach maturity (Ngugi *et al.* 2007). Once the fish reach a desired size or weight, they are harvested and consumed or sold to markets (Photo 5). Fish farming is practised all over the world as both a business enterprise and as a way to supplement the fish supply that is caught in natural water bodies such as oceans, lakes, and rivers. In many parts of the developing world, including Kenya, fish farming is conducted by community-based groups as an income generating and livelihood improvement activity and increasingly as an environmental conservation activity (Bovarnick & Gupta 2003, Liniger *et al.* 2011, Ngugi *et al.* 2007).



Photo 5: Harvested trout fish

Private entrepreneurs have been successfully constructing and operating fish farms around the Mt. Kenya Man and Biosphere Reserve since the early 1990s. Most of the first fish farming operations in the region were established mainly for income-generating purposes. However within the last decade, community groups around the mountain have begun taking up communal fish farming as a way of promoting conservation and sustainable use of natural resources as well as generating income and improving nutrition within the communities. Community fish farms in the Mt. Kenya region are usually constructed by manually excavating one or more ponds in close proximity to a reliable water source such as a river or spring (Photo 6). Water is then conveyed to the ponds via a series of pipes or an open channel, with an outlet back to the water source. Depending on the resources within the community, these ponds may be lined with concrete to prevent seepage of water into the ground and covered with netting to prevent predation of the fish (Ngugi *et al.* 2007). The location and climate where



Photo 6: Community participation in constructing a fish pond for Thuita Forest Network

the enterprise is based determine the type of fish reared, which are typically one of two primary types of fish. At higher altitudes (i.e. 2 500 m above sea level and higher) and cooler climates, trout farming is practised. Trout require a consistent source of clean, cold water (i.e. between 10 and 16°C) in order to survive. The other type of fish reared around the Mt. Kenya Man and Biosphere Reserve is tilapia. Tilapia also require a consistent source of clean water, however they are reared in the warmer waters found in the mid- and lower-elevation areas of the region (Ngugi *et al.* 2007).

3. Fish farming as an environmental conservation enterprise

In an effort to reverse the trend of environmental degradation and change attitudes of residents living around the Mt. Kenya Man and Biosphere Reserve, COMPACT has engaged communities in environmental conservation projects that also improve livelihoods since 2001. From among the many different types of income-generating projects supported by COMPACT, community-based fish farming enterprises may provide the strongest example of linking environmental conservation with improved livelihoods. Because fish farming enterprises depend upon a continuous supply of clean water, communities must actively protect the source(s) of the water from pollution and activities that result in decreased river flow (Liniger *et al.* 2011, Ngugi *et al.* 2007). In order to accomplish these conservation goals, communities have established tree nurseries (Photo 7) and planted trees within the forest and water catchment to improve water flows and prevent soil erosion, and have assisted in monitoring and preventing illegal settlement, harvesting of natural resources and pollution within the forest. These conservation activities have helped to protect the nearby forest and water catchment which form the source of the rivers and streams that sustain the fish farming enterprises, and by extension, the livelihoods of the group members.



Photo 7: Tree seedlings nursery provides seedlings for water catchment rehabilitation and an alternative source of income

3.1 Methods/approach

The Mt. Kenya COMPACT Initiative, through the GEF-Small Grants Programme of Kenya, provides financial and technical assistance to local communities to facilitate their engagement in conservation activities and development of alternative livelihood systems that provide sustainable sources of income while reducing pressure on natural resources within the Mt. Kenya ecosystem. The initiative has also facilitated dialogue and exchange of information among stakeholders and encouraged collaborative efforts among intergovernmental agencies, local government and civic society in the areas of environmental conservation and development.

The Mt. Kenya COMPACT Initiative provides financial assistance to community-based projects in the form of grants of up to 50 000 US dollars (USD) over a period of 24 months. Grants are awarded to communities through a competitive application process that follows specific guidelines. The grant proposals are reviewed and evaluated by two separate committees, the local consultative body (LCB) and the national steering committee (NSC), which are composed of environmental and development professionals who represent government ministries, NGOs, and private industry. As part of the grant award, COMPACT also provides technical expertise, monitoring support and project management training. COMPACT also mobilizes its wide network of partners and stakeholders to link community-based conservation projects with other similar community groups, private enterprises, NGOs and relevant government ministries who provide additional support during and after project implementation.

3.2 Promotion of alternative livelihood systems and influencing environmental policies through community aquaculture enterprises at the Mt. Kenya Man and Biosphere Reserve

The Mt. Kenya COMPACT Initiative has recognized the potential for community-based fish farming enterprises to provide environmental conservation and livelihood benefits to communities around the Mt. Kenya Man and Biosphere Reserve (Photo 8). In order to create the greatest impact in terms of conservation and improved livelihoods, COMPACT has supported several different types of groups, including women living near forests and/or other protected areas, out-of-school youth, converted forest cultivators and marijuana growers and would-be tree loggers. COMPACT has also supported groups which have proposed new and innovative approaches towards fish farming, integrated alternative livelihood activities and helped to develop and implement new environmental management policies which incorporate community co-management of natural resources.



Photo 8: *Sagana Women group members have taken up fish farming as an environmentally friendly livelihood activity.*

The COMPACT-supported community projects have provided opportunities for alternative livelihoods and income generation for a variety of different types of groups at the Mt. Kenya Man and Biosphere Reserve. The supported projects were based in rural communities, where the levels of education, formal employment and skills were low. As a result of the limited access and opportunities for education and formal employment within these communities, many residents relied on harvesting of natural resources to generate income and sustain their livelihoods.

- I. Many members of the Sagana Women Fish and Bee Group, comprising of 40 women and located in southwest Mt. Kenya adjacent to the Hombe Forest, relied on harvesting of natural resources (e.g. timber for fuel wood and charcoal burning) to earn income to support their families.
- II. The Fruitful Fishers Advocacy Youth Group, based in southeast Mt. Kenya, and Kimahuri Youth United Self Help Group (KYU), based in western Mt. Kenya, have a combined membership of approximately 65 youth, most of whom were out of school and owned little natural or physical capital as a basis to earn a livelihood. With no other way to support their families, they had also resorted to cultivating and selling forest resources to earn income.
- III. The Thuita Forest Network and Nyanjara Fisheries projects, located in eastern Mt. Kenya, with a combined membership of about 127, formerly contained many forest loggers, cultivators, marijuana growers, and charcoal burners who have been converted to fish farmers and stewards of their respective forests.

The aquaculture enterprises have offered group members opportunities to learn useful skills, provided employment opportunities and generated alternative sources of income from wages and member dividends. Through the projects' conservation and education efforts, the residents in these communities are also more aware of the negative consequences of environmental degradation and how they can be prevented.

In addition to developing their core fish farming enterprises, COMPACT has also supported these projects to develop new and innovative approaches to add value to their enterprises and to initiate additional livelihood activities as a way of diversifying their incomes.

- I. The Sagana Women Fish and Bee Farming group has constructed a community training facility at the site of their fish farm as a way of further diversifying income, building capacity and transferring knowledge within the community and to other communities. The community training facility, which is rented out by the group for a fee, has hosted over 20 community exchange visits, training seminars and meetings regarding environmental conservation and fish farming. The facility also serves as a cold-storage and distribution centre for fish.
- II. The KYU and Nyanjara Fisheries projects have initiated trout hatcheries with a combined capacity of about 30 000 trout eggs and 15 000 fingerlings as part of their aquaculture enterprises. These fingerlings are supplied to other fish farming enterprises and individuals for restocking of their ponds (Photo 9).



Photo 9: Trout fish fingerling

- III. KYU has also initiated a sericulture project, whereby the group has planted and raised mulberry trees to provide food for silkworm rearing. Silk fibers are harvested

from the silkworm cocoons and processed to make silk garments. The mulberry leaf (fresh or powdered) is also sold for human and livestock consumption.

- IV. The Fruitful Fishers Youth group has invested in the development of a fish feed production facility as a way of diversifying and increasing their income by supplying fish food to other fish farming enterprises in the region.
- V. The Thuita Forest Network has initiated a pig farming enterprise and a restaurant to sell their fish and pork products to the local community. All of these alternative livelihood activities have helped further diversify group members' incomes and reduced the need for cultivating and selling forest resources.

COMPACT has also promoted the development and implementation of new environmental management policies which incorporate community co-management of protected areas and natural resources through its support of aquaculture enterprises. The Forests Act 2005 allows community groups to form community forest associations (CFAs) to help co-manage the forests along with government agencies. Through the community groups' involvement in and/or creation of CFAs, the groups have assisted in the development of Participatory Forest Management (PFM) plans (TILT 2010). PFM is a system whereby local communities are actively involved in management of the adjacent forest areas together with government authorities and other stakeholders (TILT 2010). Together with KFS and stakeholders including KWS and the National Environmental Management Authority (NEMA), the COMPACT-supported community-based projects have developed PFM plans which cover approximately 50 000 ha within the Hombe, Kabarú, Irangi, Magacha and Chuka Forest stations, which are part of the larger Mt. Kenya forest. These PFM plans, together with the Forests Act 2005, form the laws that govern usage and management of these forest areas.

The successful development of PFM plans and the lessons learned from the process have served as examples and motivation for other communities in the Mt. Kenya region who would like to participate in management of their natural resources and are preparing PFM plans in partnership with KFS and other stakeholders. The Sagana Women, Thuita Forest Network and KYU community groups have also helped to influence forest management policies through their negotiation of lease agreements to utilize tracts of land within their respective forests for their fish farming eco-enterprises. The success of these aquaculture enterprises has shown forest management authorities and other community groups that conservation activities integrated with environmentally-friendly income-generating activities can be used to sustainably manage protected forest areas and their resources.

3.3 Results

3.3.1 Environmental benefits of community fish farming enterprises at the Mt. Kenya Man and Biosphere Reserve

The five COMPACT-supported fish farming projects have collectively initiated four community tree nurseries which have supplied a total of 200 000 tree seedlings that have been planted by the projects since 2004. Approximately 100 000 tree seedlings,

mostly indigenous varieties (comprising *Syzygium guineense*, *Olea africana*, *Prunus africana*, *Podocarpus milanjanus* and *Juniperus procera*), have been planted in degraded areas of the Mt. Kenya Forest and riparian areas along rivers and streams (Wass 1995). These tree seedlings are helping to rehabilitate the water catchment by reducing soil erosion, thus improving water quality of the rivers. The tree seedlings are also helping to restore forest cover which aids in the preservation of biodiversity of the forests and creates a larger carbon sink (impact now estimated at 40 000 tons of carbon/year) to mitigate climate change and its effects (Klay 2000). An additional 100 000 tree seedlings have been planted at schools and on farms to increase tree cover and to serve as woodlots to supply fuel wood to the rural community, thereby reducing the harvesting of fire wood from the forest.



Photo 10: Conservation mural at community fisheries training center

The fish farming enterprises have also created employment and income for approximately 2 000 households in communities living within the Mt. Kenya Biosphere Reserve (about 240 of who are from the projects above). Many of the members of these households formerly derived their income and livelihoods as a result of harvesting and sale of natural resources such as timber for fuel wood, charcoal and construction materials. The success of the enterprises has significantly reduced the need for harvesting of natural resources from the forest, which has also contributed to the conservation of forest, water catchment areas, and biodiversity within these areas. The community groups have also collaborated with forest management authorities to develop a successful model for co-management of the forest and its resources through the development of participatory

forest management (PFM) plans. Through implementation of the PFM plans, group members have assisted the forest service to monitor and reduce illegal settlement in the forest as well as control extraction of natural resources such as logging from the forest. The community has also adopted art as a way of extending the awareness campaign where murals are painted on public walls to pass the message (Photo 10).

3.3.2 Economic and livelihood benefits of community fish farming enterprises at the Mt. Kenya Man and Biosphere Reserve

The five community fish farming enterprises and four community tree nurseries supported by COMPACT have the potential to generate approximately USD 50 000 annually from direct sales for the groups in Mt. Kenya. The other income generating activities initiated by the groups (e.g. the community training center, trout hatchery and fish feed production facility and sericulture enterprise) are supplementing the income and helping to diversify and ensure long-term viability of the enterprises. The enterprises have directly created approximately 40 full-time employment positions and an additional 200 part-time employment opportunities during the harvesting of fish and cleaning of the ponds (Photo 11). The enterprises have also indirectly supported an estimated 300 additional jobs through the supply chain and sale of fish and other products. Due to the positive attributes of aquaculture as an empowerment project, the Kenyan government has proposed to initiate a new phase of expansion of support to fish farming enterprises targeting 28 000 new fish farms around the country (GOK 2009) as part of the country's economic stimulus programme for rural areas. This is likely to raise the income and number of jobs generated by existing and newly formed establishments. This will help transform local livelihoods for those living in the forest buffer zones and enhance conservation of natural resources.



Photo 11: Aquaculture and fish feed production have provided income and employment for 35 youth members of the Fruitful Fishers group

The community fish farming enterprises have also generated other spin off benefits to communities within the Mt. Kenya Man and Biosphere Reserve. The introduction of fish into the local markets has improved the diet and health of the local communities by providing a source of high-quality protein. The project committees have also started school bursary schemes to assist members in the payment of school fees for approximately ten students per year whose families were unable to afford the fees. Through increased incomes from both the fish farming enterprise and the sale of tree seedlings, project member households have been able to improve their livelihoods through upgrading their homes, increasing livestock herds, and purchasing household goods and equipment.

The enterprises have also assisted in empowering traditionally disadvantaged groups such as women and youth around the Mt. Kenya Man and Biosphere Reserve. Along

with the income and livelihood benefits described above, these women and youth have gained confidence in their abilities and increased financial decision-making powers within their households as a result of the success of the enterprises. They have also acquired valuable knowledge and skills in fish farming, environmental conservation, and project management which may be applied in future projects and employment. Most importantly, they have set an example and provided inspiration for other disadvantaged groups that are striving to initiate their own projects in order to improve their livelihoods.

4. Addressing challenges and sustainability

Community-based fish-farming enterprises face a number of challenges during start-up and throughout their development. The first major challenge is to raise the necessary capital and acquire the basic knowledge necessary to construct and successfully manage a fish farm profitably (Ngugi *et al.* 2007). In many cases, community groups have difficulties finding sufficient resources within their communities to construct a basic fish pond. More importantly, they lack the knowledge regarding management of the ponds. Without external inputs and support, these enterprises often struggle to become sustainable and profitable or to contribute to conservation in a meaningful way (IUCN 2005). As a result of the success of the GEF Small Grants Programme supported COMPACT initiative, local leaders, government ministries, NGO stakeholders, micro-finance lenders, and other donors are increasingly recognizing community fish farming as a sustainable, environmentally-friendly community development enterprise. These partners and stakeholders are providing significant support to community groups in the form of capacity development and technical expertise as well as grants, low-interest loans, materials and equipment for development, improvement and expansion of fish farming enterprises (Photo 12).



Photo 12: Communities receive capacity building and training as part of COMPACT projects

Even after fish ponds have been constructed, basic knowledge and management capacity acquired and income generated, community fish farming enterprises still face a number of challenges in attaining long-term viability. Some of these challenges include establishing, maintaining and expanding the market(s) as the enterprise develops (Ngugi *et al.* 2007). Due to the lack of natural water bodies in the Mt. Kenya region and the somewhat limited availability of fish in the local markets, local residents have not had many opportunities to consume fish and have historically preferred more traditional sources of meat such as beef, mutton and poultry. The limited availability of fish in the local markets and relatively high cost of fish compared to more traditional

sources of meat have also resulted in low levels of fish consumption amongst local residents. However, the region has experienced a marked increase in tourism in the last ten years, with visitors coming from other parts of Kenya and foreign countries where fish is preferred over other types of meat. In order to meet the increased demand for fish, hotels, restaurants and supermarkets have begun offering a variety of fish entrees and products. The growing number of fish farming enterprises and wider availability of fish has also reduced prices and local residents have begun integrating fish into their diets as they discover the health benefits of fish and learn how to prepare different fish dishes. These factors have opened up the local market for fish in the Mt. Kenya region, and demand is expected to increase significantly over the next several years.

Although the market for fish is growing in the Mt. Kenya region, entering the market can be a challenge and will depend on the ability of the enterprise to successfully market itself and compete with other existing fish farming enterprises. The long-term viability and success of the enterprise will also hinge on the ability of the enterprise to sustain and expand its market by consistently maintaining deliveries of fish of sufficient quality and quantity to meet orders and market demand. The ability of an enterprise to meet these challenges will likely be impacted by issues such as transport and infrastructure. In many cases, community fish farming enterprises are in rural areas served by rough earthen roads that may become impassable in rainy weather, sometimes for weeks at a time. The distance to the point of sale and availability of refrigerated transport vehicles can also impact the quality and shelf life of the fish. Thus, establishing necessary infrastructure (i.e. muram or paved roadways and on-site cold storage) and reliable transport services are critical (Ngugi *et al.* 2007). Other factors affecting the success of the enterprise include the governance of the project (e.g. professionalism and financial management), establishing clear and legal ownership of project assets, and the ability to obtain long-term land tenure agreements (Ngugi *et al.* 2007). The development of strong and collaborative working relationships with partners and stakeholders such as CFAs and the local District Fisheries Office are also crucial to sustaining long-term viability and success.

The lack of diversification of income sources and activities can also create a challenge for many community-based fish farming enterprises (Ngugi *et al.* 2007). In many cases, community members engaged in fish farming are not engaged in other income-generating activities due to a lack of sufficient resources and skills. This lack of diversification of income sources can severely strain the enterprise when income levels are low (e.g. between harvests), the fish ponds require significant re-investment of income to address maintenance issues, or if the ponds require frequent



Photo 13: KYU group members spinning silk harvested as part of their sericulture enterprise

restocking as a result of possible high levels of fish mortality. Thus, it is critical for communities who are engaging in fish farming to also initiate other IGAs such as tree nurseries or sericulture enterprises, depending on their specific situation and the available resources (Photo 13). As discussed above, several of the fish farming enterprises supported by COMPACT have initiated innovative income-generating activities related to their fish farming enterprises.

5. Conclusions and implications for the AfriMAB network

The landscape approach as piloted by the COMPACT Initiative around the Mt. Kenya Man and Biosphere Reserve as well as seven other critical sites around the world seems to be the way to go for protecting MAB reserves and critical ecosystems. Developing pilot initiatives that later attract other donors and partners for additional support has proven to be a successful way of creating sustainable conservation programmes.

Community fish farming enterprises at the Mt. Kenya Man and Biosphere Reserve have successfully integrated environmental conservation activities with improved and sustainable livelihood systems. The Mt. Kenya COMPACT Initiative has been at the forefront in supporting the development of fish farming enterprises, providing financial, technical and monitoring support to five diverse projects in different areas around the Mt. Kenya Man and Biosphere Reserve. As a result of the success of these pilot projects, many other community groups have started fish farming enterprises to generate income and help conserve the environment within and around their communities. Aquaculture has now been recognized all around the biosphere reserve as a promising enterprise by other donor organizations and the Ministry of Fisheries who are now supporting development of new fish farming enterprises in the Mt. Kenya region and other areas of Kenya as an empowerment and income-generating project targeting rural women and youth. The success of the enterprise in Mt. Kenya can easily be replicated by other Man and Biosphere Reserves in Africa where unmet livelihood needs are driving communities to turn to unsustainable ways of utilizing natural resources.

6. Future of community-based fish farming at the Mt. Kenya Man and Biosphere Reserve

The COMPACT-supported projects have created a significant level of awareness regarding the benefits of fish farming and consuming fish-based meals. The projects have also imparted skills to local residents regarding fish rearing and preparation and how to integrate fish into their diets.

The number of community fish farming enterprises around the Mt. Kenya Man and Biosphere Reserve is expected to increase significantly in the coming years as a result of increasing demand for fish in the region and the proven viability of community fish farming enterprises as a sustainable, profitable conservation-based enterprise. On-going improvements in infrastructure (e.g. development of paved and all-weather roads) and improved access to transportation will also help to open up new markets

and better connect fish farming facilities with regional and national markets. The successes of the former and current COMPACT-supported fish farming projects are already being replicated through mentoring of other community groups living around the Man and Biosphere Reserve. This has been accomplished through exchange visits amongst the groups (Photo 14), practical training workshops held at the facilities of the existing fish farming enterprises and communication through the Mt. Kenya Network group email.



Photo 14: Community exchange visit to learn about fish farming

The existing and future community groups will be encouraged to continue to reinvest a percentage of the profits from their fish farming enterprises in environmental conservation activities that protect the surrounding forests. Protection of these forests which form the water catchments will also help to ensure the long-term viability of the enterprises by ensuring a consistent source of clean water to the fish ponds. Community groups engaging in fish-farming will also be encouraged to initiate other environmentally friendly income-generating activities such as tree nurseries, ecotourism sites, woodlots, fruit tree farms, and sericulture to diversify their income sources and help ensure sustainability.

Efforts by the existing community fish farming groups, along with the government and other stakeholders, to integrate fish farming into the National Poverty Alleviation Policy as an economic empowerment enterprise will also continue. This will be aided by increasing support from government ministries and programmes, including greater staffing at District Fisheries Offices and increased allocation of resources through government devolved funds like the Constituency Development Fund (CDF), which will help to reduce financial barriers to development of community fish farming enterprises and help to address gaps in the knowledge and skills required to successfully manage such enterprises. COMPACT will also continue to support new and innovative community initiatives that utilize fish farming to help promote conservation of the Mt. Kenya Man and Biosphere Reserve.

7. Implications for the larger AfriMAB network

The success and growth of fish farming enterprises around the Mt. Kenya Man and Biosphere Reserve is also likely to positively influence the development of similar enterprises in other regions within Kenya and throughout Sub-Saharan Africa. Through the interactions within and among international donor organizations, NGOs, and government officials in different countries, the success cases and lessons learned from fish farming at the Mt. Kenya Man and Biosphere Reserve and other areas will be shared.

From the achievements and high level of success of the aquaculture project, it is possible to make a strong case for adopting similar projects as a way of empowering communities living in many of Africa's Man and Biosphere Reserves that have continued to endure pressure from growing livelihood needs from the community.

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Reconciling Biodiversity Conservation with Sustainable Development: Projects in the Kruger to Canyons Biosphere Region, South Africa

Reconcilier la Conservation de la Biodiversité avec le Développement Durable: Projets dans la région de biosphère de Kruger à Canyons, Afrique du Sud

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Abstract

In this paper the Kruger to Canyons Biosphere Region (K2C) describes four projects: The K2C Voluntary Carbon Off-set System, the partnership with the Rhön Biosphere Reserve in Germany, the development of a Bio-cultural Protocol, and proposed Connectivity Conservation through River Corridors.

By linking tourists to carbon sequestration that also contributes to food security, creating north-south joint projects through the partnership with the Rhön Biosphere Reserve in Germany, ensuring capacity building, access and benefit sharing and environmental justice in the development of Bio-Cultural Protocols, and also demonstrating connectivity conservation, the benefits of subscribing to UNESCO's MAB framework's principles in one landscape are demonstrated.

The paper shares responsible strategies towards projects, owned and implemented by local actors, which reconcile biodiversity conservation with sustainable development. These projects jointly create linkages between humans and nature and between different biomes and environmental justice.

Key Words: Biosphere Region; connectivity; traditional healers; carbon off-set; partnerships

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Resume

Dans ce document, la région de biosphère de Kruger à Canyons (K2C) décrit quatre projets: Le K2C Voluntary Carbon Off-set System (Système de crédits-carbone), le partenariat avec la Réserve de biosphère de Rhön en Allemagne, le développement d'un protocole bio-culturel et le projet Connectivity Conservation through River Corridors (Conservation par la connectivité à travers les corridors fluviaux).

Par la connexion du tourisme à la séquestration des gaz carboniques contribuant également à la sécurité alimentaire, la création de projets nord-sud par un partenariat avec la réserve de biosphère de Rhön en Allemagne, la mise en place du renforcement des capacités, le partage de l'accès et des avantages et l'équité environnementale dans le développement de protocoles bio-culturels ainsi que la démonstration de la conservation par la connectivité, les avantages d'adhérer aux principes du cadre du MAB de l'UNESCO dans un seul paysage sont démontrés.

Le document vise à partager les stratégies responsables pour l'avancement des projets, détenus et mis en œuvre par des acteurs locaux, réconciliant la conservation de la biodiversité avec le développement durable. Ces projets mis en commun créent des liens entre les hommes et la nature et entre les différents biomes et l'équité environnementale.

Mots-clés: Région de biosphère; connectivité; guérisseurs traditionnels; réduction du CO₂; partenariats

1. Introduction

The Kruger to Canyons Biosphere Region (K2C) is located in the north-east of South Africa and spans parts of the Limpopo and Mpumalanga Provinces (Figure 1). Altitudinal ranges from the Escarpment to the Lowveld link the grassland, afro-montane and savannah biomes in this landscape through the Sabie, Sand, Blyde and Olifants Rivers and contribute to the high biodiversity of the region.

In this 2.5 million hectare landscape, which comprises of a core zone (35.4%), a buffer zone (18.6%) and a transition zone (46%) (Figure 2), reside 1.5 million people, of which the majority live in the transition zone.

The K2C achieved its international biosphere reserve status through a stakeholder participation process driven by local actors and was designated by UNESCO in 2001. Since 2007 the management entity of the K2C is in the form of a voluntary association, the K2C Representatives Council. It has been established according to a constitution and has elected an executive committee (EXCO) that meets on a regular basis. The association is a non-profit organization. At a workshop on organizational development, the forming of a non-profit company for the management of the K2C was proposed in order



Figure 1: Logo of the Kruger to Canyons Biosphere Region

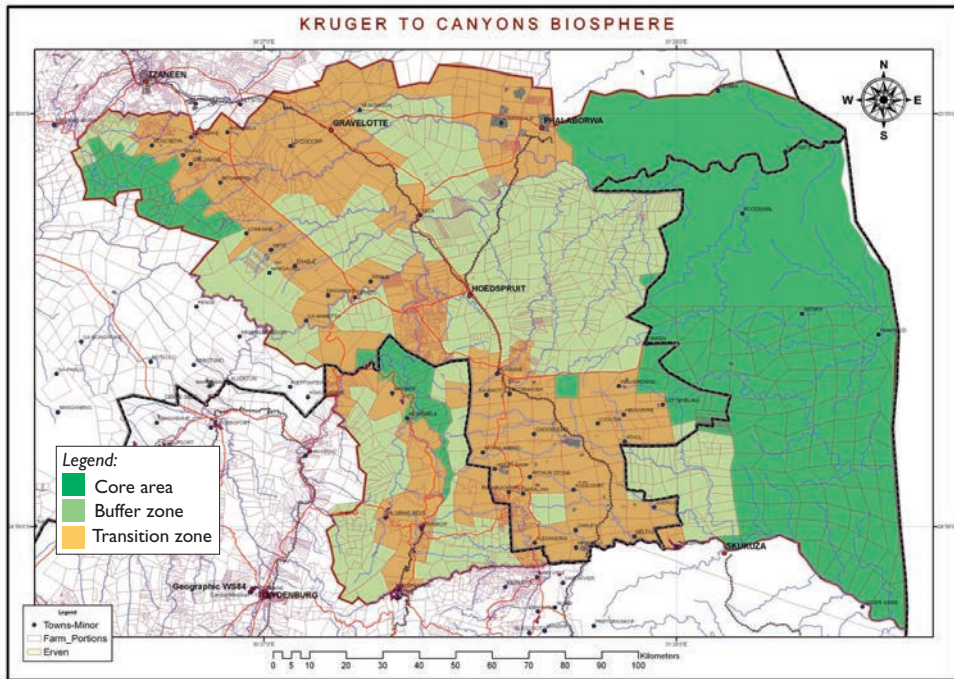


Figure 2: Zonation map of the Kruger to Canyons Biosphere Region

to have a better legal standing and to improve the possibilities of receiving funding (K2C 2010). The Kruger to Canyons Biosphere Reserve Region Non-profit Company, with a Board of Directors of six, was subsequently registered to facilitate management of the K2C.

Since its inception, the K2C has demonstrated that project orientated partnerships between government entities, research and education institutions, civil society and rural communities are the optimum method to achieve locally owned reconciliation of biodiversity conservation and sustainable development.

This paper aims to demonstrate through the description of four projects how the principles of UNESCO’s Man and the Biosphere Programme are locally applied by capitalizing on a number of the great features of the region in conjunction with developments in South Africa and global discussions.

2. Project 1: Mitigating climate change through the establishment of a voluntary carbon off-set programme

2.1 The World Network of Biosphere Reserves and climate change

The Man and the Biosphere (MAB) Programme and the World Network of Biosphere Reserves (WNBR) apply an integrated approach in addressing biodiversity and climate change challenges.

They rely on interdisciplinary mechanisms combining science, culture and education, to:

- find solutions for reducing the current rate of biodiversity loss for the benefits of both the environment and human populations around the globe; and
- support the implementation of relevant provisions under the main multilateral environmental agreements dealing with biodiversity, including the Convention on Biological Diversity.

The MAB Programme and WNBR are also committed to realizing the main objectives of the UNESCO Strategy for Action on Climate Change to:

- build and maintain the climate change knowledge base through science, assessment, monitoring and early warning; and
- promote mitigation and adaptation to climate change through enhanced education and public awareness.

2.2 Introduction to Project I

The mitigation and sequestration of carbon in support of a reduction in climate change is an important focus area for biosphere reserves to engage in, and is the leading intention behind the development of the K2C Carbon Voluntary Off-set Initiative. The general concept is to link the sequestration of carbon in community development projects to the extensive tourism facilities and businesses within its region. The K2C region is predominantly tourism focused and as a result it has a large number of both local and international tourists visiting the region throughout the year (Figure 3). A large number of these visitors are becoming more conscientious and aware of the carbon produced during their stay on holiday (such as in the K2C) and are looking for ways to off-set or counteract any additional carbon quantities produced during their visits to this region. The majority of the tourism services and facilities offered within the area are focused on the enjoyment/use/benefits of the general environment. Thus it is natural for conscientious visitors to be aware of the impact they are having on the area — such as carbon production.



Figure 3: Big Five Game Viewing is one of the more popular tourism activities within the K2C Region

2.3 Project concept

The basic concept behind the project is to establish a channel and facility to allow for the more conscientious tourists to the region to be able to off-set their carbon

production in a legal, transparent and controlled manner through a voluntary contribution opportunity.

This will be achieved through the establishment of an independent MANCO (Management Committee) that will fall under the K2C Board and non-profit registration, yet will function autonomously and will be responsible for the transparent management and administration of all monetary credits traded within the region. The established MANCO will be responsible for the collection and distribution of the monies received and the effective management of the carbon off-set projects supported with these funds.

Contributions by tourists will be conducted entirely on a voluntary basis and feasible guidelines will be given as to the amount that should be contributed to off-set the average carbon produced per night stay.

All contributions received will be used directly towards the sequestration of carbon in various projects. As an initial phase, a pre-identified pilot project will be implemented through which all initial monies will be channeled. The intention behind an initial pilot project will be to establish a secure and concentrated project through which further information and data collection can occur to ensure and validate the levels of carbon sequestered by the various measures implemented. The pilot project will include the newly designed concept of Agro-forestry which is largely focused around the increased sequestration of carbon through new techniques employed together with the production of much needed food and cash crops to feed the communities in which the project occurs. It is important that the initial pilot project will have the following characteristics:

- Its main focus will be on the sequestration of carbon.
- It will have a secondary focus that offers an additional community benefit such as food security, health support, tourism development or educational opportunities.
- It will act as a learning site for the development of a greater knowledge base on relevant aspects relating to carbon sequestration and specifically the implementation and effects thereof on a regional scale.
- It will act as a research site for the development of a greater regional knowledge base on carbon sequestration as well as to enable research into the specific sequestration abilities and quantities of identified plant species.
- It needs to be in a safe and secure environment where the long-term implementation of carbon sequestration can be guaranteed.
- The project must have local and direct benefits to the K2C community.

2.4 Project status

A six month feasibility study has been successfully completed, focusing on the feasibility of the development of the Voluntary Carbon Off-set programme. The latter included communications and participation from tourism facilities and services within the region, together with in-depth insight into the functioning of a carbon off-set programme and the realities involved therein. Further to that, Phase I of the Implementation phase has been initiated—this is focused solely on the planning and preparations to enable implementation and will result in the establishment of a legal management body

(i.e. the MANCO) and the development of operational and implementation guidelines to ensure the successful initiation of the initiative. Additionally, this phase will include the securing of partnerships and commitment from an initial number of lodges and tourism facilities within the region as the initiators to the fund. A final development of this phase will include development of marketing and training material as well as detailed funding and implementation plans. It is expected that this project will be fully up and running from mid to end 2012.

3. Project 2: *The benefits of a north–south partnership through the establishment of the K2C (South Africa) and Rhön Biosphere Reserve (Germany) partnership*

3.1 *WNBR focus on partnerships?*

Building on activities at site and national levels and encouraging collaborative activities at bilateral, sub-regional and regional levels are crucial links in contributing to the development of the WNBR, and in promoting the exchange of information between biosphere reserves in different countries.

3.2 *Introduction to Project 2*

The K2C-Rhön partnership was initiated in June 2007 with an initial investigatory visit by K2C delegates to the Rhön Biosphere Reserve in Germany (Figure 4). It was subsequently followed up with a return visit by Rhön delegates to the K2C in March 2008.

The objective of the cooperation is to use and develop the two areas as learning platforms for all stakeholders who are involved in the biosphere reserves/regions in order to foster

- mutual inspiration and learning of the two biosphere reserves;
- sharing experience, knowledge and problem resolution approaches;
- networking between local actors;
- joint ventures and to provide a platform for trade options for the private sector.

The partnership was further ratified by the official signing of a Memorandum of Understanding between both biosphere



Figure 4: K2C delegation in the Rhön country side



Figure 5: Official signing ceremony in Bonn during COP 9

reserves at a UNESCO side event during the ninth meeting of the Conference of the Parties (COP 9) at the International Convention of Biodiversity in Bonn in June 2008 (Figure 5).

3.3 Project concept

Initially identified fields of cooperation within the development of the partnership have and will continue to focus on the following fields/frameworks of interest:

- (a) Renewable energies.
- (b) Trade relations in the private sector/the establishment of private public partnerships.
- (c) Projects fostering sustainable development.
- (d) Marketing and promotional projects aimed at both the biosphere reserve concept in general as well as individual aspects within each biosphere reserve.
- (e) The education sector on different levels from schools to tertiary level.
- (f) International exchange opportunities for students and individuals within each biosphere reserve to visit and exchange skills, knowledge and experiential opportunities with each other.

3.4 Project status

The partnership is growing in strength from year to year. In addition to the initial identified focus areas as outlined above, there have been further benefits that have been obtained through this partnership which include:

- The formalisation of the partnership through an official signing of a Memorandum of Understanding at a UNESCO side event during COP 9 in Bonn in 2008.
- The establishment of a strong partnership between the Southern Cross School in K2C and the Martin-Pollich-Gymnasium (MPG) in the Rhön. This partnership was fortified in the middle of 2011 with the initial exchange visit of Southern Cross school learners who visited the MPG on an educational and experiential exchange opportunity. Funding applications have been submitted to enable a return visit of the MPG students to Southern Cross in early 2012.
- Funding from UNESCO Germany has been obtained as a direct result of the partnership and links established, for the conducting of two feasibility studies: (i) investigating the potential development of a Voluntary Carbon Off-set Programme with the many lodges and tourism industries in the region; and (ii) looking at potential options with regards to the use of funding received for carbon sequestration project options.
- The completion of a feasibility study as well as a full and detailed “ownership and beneficiation” study completed on the potentials of a Hydro Electricity Station to be developed at the dam wall on the Blyde River. Due to extreme benefits to be obtained in this project, it is now in a complex political discussion phase.
- The establishment of regular student exchanges for young tertiary students from the Rhön to come to K2C in South Africa and share their knowledge, experience and skills in furthering project development within the region.

- The joint partnership between the Southern Cross School and MPG will act as the initiation of the formation of an international network of schools called Schools in Biospheres. This initiative will be established by the Southern Cross School and will look at inviting schools linked to biosphere reserves all over the world to form a united network to allow for the sharing of experiences, knowledge and experiential exchanges.
- The development of and participation in a Uni-Key project. Ten universities, research organisations, chambers, enterprises and enterprise associations from Belgium, Denmark, Germany, Greece, Italy, Portugal, Spain and South Africa (K2C) are collaborating in Uni-Key to develop entrepreneurial skills among mobile students. The outcome of the project is planned to be an online course (Uni-Key 2012).

There are a number of additional projects and opportunities that have been identified and will be investigated over the next few years as the partnership continues to grow and flourish.

4. Project 3: Biosphere reserve as a partner in facilitating the development of a bio-cultural protocol—a case study of the K2C and the Bushbuckridge Traditional Health Practitioners

4.1 Introduction to Project 3

Communities have rights to access natural resources and they also have rights with regards to the protection of their traditional knowledge. These rights are internationally enshrined in the 1992 International Convention on Biodiversity and nationally in the South African National Environment: Biodiversity Act (NEMBA) and its Bio-prospecting, Access and Benefit Sharing Regulations of 2008.

The Bushbuckridge Traditional Health Practitioners (BTHPs) play an important role in the well-being of rural communities in the K2C. Traditional healing is a support system and a source of cultural identity. However, BTHPs face many challenges in a changing world, also with regard to access to natural biodiversity on which the practising of their trade is based (Jonas *et al.* 2010).

4.2 Project concept

The K2C, in partnership with Natural Justice—a legal based NGO—facilitated a series of workshops with the BTHPs, where information about the laws were shared, procedures of accessing state forests and sustainable harvesting were explained and a Bio-cultural Protocol was developed (Figure 6).

4.3 Project status

The Bio-cultural Protocol (BCP) has been developed by the BTHPs with the assistance of K2C and Natural Justice (K2C 2009a). The K2C also developed and printed

a “Lessons Learnt and Process Document” to further assist other organizations or areas wishing to replicate the principles and process (K2C 2009b). The development of the Protocol also resulted in additional benefits such as the sharing of information amongst the Traditional Health Practitioners, which was historically not an open practice, through a unified and coordinated unit of BTHPs.

As a further pilot project to showcase the practicality and implementation of the developed BCP, K2C further linked the BTHPs with a locally based cosmetic company, Godding & Godding, with whom they are in the process of entering into a benefit sharing agreement. This is not a straightforward or easy process as explained by Jonas and Shrumm (2010) and Köhler-Rollefson (2010). The process started off with the development of a non-disclosure agreement drafted by Natural Justice. Research will be done on the application of knowledge about certain plant species before a benefit sharing agreement is to be developed and a business partnership entered into (Natural Justice 2012).

K2C and Natural Justice also plan to interact further with the BTHPs in order to develop a capacity building and development framework for which implementation funding will be sought.



Figure 6: Meeting with Traditional Health Practitioners

5. Project 4: The potential of using biosphere reserves to demonstrate the implementation of connectivity conservation—the case of the K2C proposed River Corridor project

5.1 Introduction to Project 4

There is consensus that biodiversity conservation ought to take place both inside and outside protected areas if biodiversity targets are to be met. Given the potential inter-linkages of areas inside and outside protected areas in ecosystems, the ultimate structure of biodiversity conservation should be Bioregional Landscape Management and Connectivity Conservation. While many factors might affect biodiversity conservation, the use of economic incentives is argued to be potentially one of the most effective mechanisms for mainstreaming biodiversity conservation in bioregions.

Biosphere reserves are uniquely positioned to drive such initiatives and the Kruger to Canyons Biosphere recently conducted a feasibility study to this effect (Biovista Conservation Consultancy 2009).

5.2 Project concept

The proposed Kruger to Canyons River Corridor for the Olifants and Blyde Rivers, falling within the 100-year flood line, straddles different land uses and land tenures. The view of the proposed Blyde River–Olifants River Corridor is to restore ecological integrity and reinstate ecosystem services (Figure 7). The concept proposes an integrated and innovative approach by capitalizing on a number of the great features of the region in conjunction with developments in South Africa and global climate change discussions and approaches. While contributions of the proposed approach to biodiversity conservation and climate change mitigation will be obvious, it will contribute equally to the sustainable development of rural and poor communities.

The Project's goal is that by 2014, water quality and flow of the Blyde and Olifants Rivers and their tributaries within the K2C will meet improved standards and all riparian vegetation will be un-fragmented or in a state of rehabilitation with the aim for a minimum width following the 100-year flood line (Figure 8). The specific five-year project objective is: Local economic development while conserving prioritized river corridors in the Kruger to Canyons Biosphere Region.



Figure 7: A section of the Olifants River that needs reparation



Figure 8: A portion of the healthier section of the Blyde River which will act as a benchmark for the rest of the River Corridor Project

5.3 Project status

The K2C, with its mandated provincial partners, has now arrived at a transitional phase of moving from 'sharing a vision' towards concrete implementation of the Olifants and Blyde River Corridor project. The project is to support local economic development, and is seeking support to make this happen during a small window of opportunity whereby multiple key stakeholders are ready to move at the same time in the same direction.

In a collaborative undertaking, the role of the K2C is very much a facilitator of collaboration with the view that "the whole is more than the sum of its parts" (Gates & Morgan 2003). This does however require a clear understanding regarding the

different roles and responsibilities of the participating organizations and trust among them. Finally, if successful with fundraising, the work automatically requires a project management unit. If not practical and logistically feasible within existing institutions, this would require additional capacity. However, actual organization, size and operations will be subject to scale and focus of funding received and actual set-up will be best determined in that context.

6. Conclusion

By describing four projects (The Voluntary Carbon Off-set System; the partnership with the Rhön Biosphere Reserve; the development of a Bio-cultural Protocol; and the proposed Connectivity Conservation through River Corridors project) the benefits of subscribing to the principles of the UNESCO MAB programme have been demonstrated. To achieve a sustainable life for all, linkages between humans and nature and between different biomes and environmental justice need to be achieved.

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Nesting Ecology and Conservation of Nesting Turtles in Songor Biosphere Reserve

Ecologie de la Nidification et Conservation des Tortues de Ponte dans la Reserve de Biosphere de Songor

DICKSON YAW AGYEMAN¹ • SAMUEL ANNAN RIVERSON² • AGYEKUMHENE ANDREWS³

Abstract

All over the world, the population of sea turtles is declining, and the situation is not different for Ghana. The sea turtle population, as has been observed, is declining both in the waters and on the nesting beaches of Ghana. There is also the possible extirpation of some species of sea turtles that once used Ghana's sandy beaches as their nesting habitats. The green turtle, loggerhead turtle and the hawksbill turtle that are believed to have once nested on the beaches of Ghana do not use most of these areas any more. A survey conducted along the beaches of the Songor Ramsar site (now the Songor Biosphere Reserve) in Ghana revealed that most areas along the beaches are important nesting grounds for sea turtles. There was however a reduction in the population of the sea turtle in along the beaches due to activities of the coastal dwellers that are affecting the turtles and their nesting habitats. There is therefore the need for conservation measures to help revive the population of turtles to a healthy level. The Wildlife Division of Ghana used education, law enforcement and community participation to protect the sea turtles. There has been a reduction of sea turtle killings by 95% over the period of 5 years. Turtle egg collection has also gone down drastically. There is however the issue of dogs predated turtle eggs in the biosphere reserve.

Key Words: Sea turtles; nesting; clutch size; incubation period; hatching success; leatherback; olive ridley

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Resume

Dans le monde entier, la population des tortues marines connaît un déclin et la situation n'est pas différente au Ghana. Selon les observations, elle est en déclin dans les océans mais également sur les plages de ponte au Ghana. Il existe aussi une possible extinction de certaines espèces de tortues marines qui, dans le temps, utilisaient les plages sablonneuses du Ghana comme habitats pour l'éclosion des œufs. La tortue verte, la tortue caouanne et la tortue imbriquée auraient déposé leurs œufs sur les plages du Ghana dans le passé mais n'utilisent plus ces zones aujourd'hui. Une étude menée le long des plages du site de Songor Ramsar (aujourd'hui la réserve de biosphère de Songor) au Ghana a révélé que la plupart des zones longeant ces plages constituent des terrains de ponte importants pour les tortues marines. Cependant, on a constaté une réduction de la population des tortues marines le long des plages en raison des activités des habitants côtiers, affectant les tortues et leurs habitats de ponte. Il est donc crucial de lancer des mesures de conservation pour aider à restaurer la population des tortues à un niveau acceptable. La Division de la faune au Ghana s'est appuyée sur l'éducation, l'application de la loi et la participation de la communauté pour protéger les tortues marines. En résultat, une réduction de 95% des massacres de tortues au cours d'une période de 5 ans a été remarquée. La collecte des œufs de tortues a baissé de manière considérable. Mais le problème des chiens prédateurs sur les œufs de tortues dans la réserve de biosphère persiste.

Mots-clés: Tortues marines; ponte; importance des couvées; période d'incubation; succès d'éclosion; tortue luth; tortue bâtarde

1. Introduction

Sea turtles are ancient reptiles that inhabit the world's oceans, except the Arctic Ocean. Sea turtles pre-dated many dinosaurs and have been swimming the Earth's oceans for well over 100 million years. The first turtles appeared during the Triassic period, 245 to 208 million years ago, with the earliest known sea turtle fossil record appearing in the late Jurassic period, 208 to 144 million years ago. Together with marine snakes, crocodiles, and iguanas, they are the only surviving reptiles adapted to sea-water existence.

Marine turtles play important roles in the marine ecosystem, as well as the terrestrial environment. Their important functions span from ecological to humanitarian aspects. Sea turtles are seen as natural resources by humans. They are used in diverse ways for dietary, medical, cultural, economic, and religious human needs and wants (Agyekumhene 2009, Laqueux 1998, Roberts *et al.* 1999).

In spite of the importance of sea turtles in the marine ecosystem, their population has continuously declined over the years resulting from kills, pollution and habitat degradation (Armah *et al.* 1997). They are listed on the IUCN list of endangered species (IUCN 2004). Although there are laws in Ghana that makes it an offence punishable by fines, imprisonment or both, to capture, kill or sell part or the whole of sea turtles, there

are still high incidences of poaching and habitat degradation (through sand mining and pollution at the beach) among many coastal communities.

2. Methods

2.1 Study site

The study was conducted within the Songor Biosphere Reserve (SBR), situated in the south-eastern part of Ghana. This area was selected for the current study because it is one of the most intensive nesting areas on the sandy beaches of Ghana. The SBR has a lot of small fishing villages and beach resorts dotted along its beach.

2.2 Data collection

2.2.1 Beach patrol

Data collection was carried out between October 2004 and September 2010 on a 10 km stretch of beach. The nesting beach was patrolled during the night to look for nesting turtles, nests, non-nesting emergences, poaching and dead turtles. When a turtle was encountered, the position of the nest was marked using a Global Positioning System (GPS) to allow future visits to the nest. The nest was left to develop *in situ*. Depredated nests were also identified, marked using the GPS, and the agent of depredation determined.

3. Results

3.1 Nesting activities and nest numbers

The SBR serves as a nesting site for three species of turtles namely leatherback, olive ridley and green turtle (Figure 1). The olive ridley turtle is the most dominant of the three species that use the beaches of Ada Foah as nesting habitats (Agyekumhene 2009). Sea turtles nest primarily between the months of October to February. The olive ridley however nests all year round (Agyekumhene 2009, Amiteye 2002, Armah *et al.* 1997). Nesting intensity of the turtles along the beach of the SBR increases from the West to the East.



Figure 1: Sea turtle species that use the Songor Biosphere Reserve as nesting sites. From left to right: Leatherback, Green Turtle, Olive Ridley.

Sea turtles nest in two- to three-year cycles. The number of nests deposited within a season depends on the nesting population. Nest numbers therefore differ between the seasons. In a bad season, as few as 10 nests may be found while as many as 600 nests are recorded in a good season.

3.2 Clutch size

Clutch size is the number of eggs laid in an egg chamber. The clutch size differs depending on the species and also the time of the nesting season (Shanker *et al.* 2003). The same species of turtle will normally lay similar clutches during a season (Miller *et al.* 2003). The average clutch size recorded for the leatherback turtle in the area is 82 ± 6 eggs/nest while an average of 119 ± 14 eggs/nest have been recorded for the olive ridley.

3.3 Incubation period

The incubation period is the time taken for the turtle eggs to hatch. The incubation period is dependent on the temperature of the area (Shanker *et al.* 2003). The incubation period is practically the same for both leatherbacks and olive ridley that nest in the SBR. The incubation period for the leatherback is 59 ± 6 days and 60 ± 5 days for the olive ridley.

3.4 Hatching success

Hatching success is very high within the SBR and does not vary significantly among species of turtles that nest in the area (Agyekumhene 2009). The high hatching success measured for sea turtles in the area could most likely mean that prevailing conditions in the nesting area are suitable and optimal for the development of sea turtle eggs. The hatching success is 88.3% for the leatherback and 92.4% for the olive ridley.

4. Threat to nesting turtles in the Songor Biosphere Reserve

Nesting turtles face diverse challenges when visiting sandy beaches to produce their young ones. Turtles face threats both in the water and on land when they come to lay eggs in the sand.

4.1 Anthropogenic threats

4.1.1 Fishery interaction

Turtles in the wider marine ecosystem face threats from pair trawling vessels, local fishermen and detached nets (ghost nets) that continually trapped and drowned turtles (Figure 2). Local fishermen occasionally negotiate for the release of trapped turtles for a fee. Turtles are an integral part of the catch of fishing expeditions by commercial and local fishermen. Over the years, high numbers of dead turtles encountered on the beach, coincide with the period when numerous fishing trawlers were spotted on the sea at night. This may suggest the unavailability of Turtle Excluder Devices (TED) on trawlers and may be responsible for the high number of dead turtles encountered.

Physical examination reveals drowning and injuries (head and flippers) as the possible causes of death. Dragging a turtle in a fishing net for over 45 minutes can drown and kill them. Collision of turtles with fishing boats can cause serious injuries from the propeller which can lead to deaths (Laqueux 1998).



Figure 2: Sea turtles caught by local fishermen in a fishing line (left) and in a fishing net (right)

4.1.2 Poaching

Poaching is the collection of female turtles from the nesting beach. Nesting turtles are occasionally poached and killed for food (Figure 3). The turtle may be poached at any time between ascending the beach through oviposition to descending. The poached turtles are normally flipped over and dragged from the beach leaving a line which indicates poaching. Poached turtles are sold for money or killed for food by the poachers who are mostly fishermen (Armah *et al.* 1997). The poachers may either sell the turtle in villages inside the biosphere reserve or outside.

Through the law enforcement patrols by the Wildlife Division within the area, poaching activities have reduced by 95% over the past years. The presence of the officers from the Division on the beach is enough to scare potential poachers from collecting the female turtles. Conservation education in schools and communities within the reserve has also contributed a lot to the reduction in killing of turtles. Through education, the fishermen are now aware of some of the importance of having turtles in the water and on the beaches and hence the need to protect them.



Figure 3: Poached leatherback turtle



Figure 4: A fisherman collecting turtle eggs

4.1.3 Egg collection

Local fishermen sometimes collect turtle eggs for food or to sell (Figure 4). The turtle eggs may be taken at any time during oviposition or a few days after oviposition. A female turtle may lay as many as 140 eggs in a hole (Agyekymhene 2009, Amiteye 2002). All the eggs are normally collected by the humans and used for food. With continued law enforcement patrols, the incidences of turtle egg collection have reduced in the area. Another factor that could have contributed to the reduction in turtle egg collection is the education programme in schools and communities.

4.1.4 Predatory activities

Sea turtles and their eggs are exposed to predation activities both in the marine environment and on land. Predation occurs throughout the entire life cycle of the turtles. At the egg stage, predators such as dogs, pigs, raccoons, foxes, ghost crabs (*Ocypoda* sp.) and humans feed on the turtle eggs. At the hatchling stage, predators such as dogs, pigs, raccoons, foxes and birds feed on the baby turtles as they make their way into the water. While in the water, big fishes like sharks feed on the baby turtles.

In the SBR, dogs and humans are the main predators of turtle eggs and they destroy about 50% of the total number of nests deposited during the nesting season (Agyekumhene 2009). The dogs that sniff and find the location of the eggs, may depredate the nest at any time between oviposition and hatching (Figure 5). Dogs sometimes dig out the hatchlings and feed on them before they get the chance to emerge and go into the sea.



Figure 5: Predation of turtle nest by feral dogs

4.2 Natural threats

4.2.1 Environmental conditions

Environmental conditions differ along sections of the sandy coast of Ghana. Estuarine, rocky and lagoon areas characterize most sections, while scattered but highly populated communities exist. Coastal beaches within the site are dynamic land forms which are constantly being subjected to erosion and accretion. The conditions of the beach reflect the local balance and imbalance between deposition (beach gain) and erosion (beach

loss). The rapid and successive loss has resulted in the formation of steep cliffs along the coast (Agyeman 2008). Marine turtles are exposed to these conditions when they emerge to nest at night. Turtles nest when they locate favorable habitat devoid of any threat to the species and the eggs in the nest.

The preferred sandy condition for nesting is fine grain sand (0.02–0.002 cm) at a depth of 40–80 cm. After emerging from sea, turtles move between 8–50 m or more into land, depending on the species and the beach condition to locate suitable nesting spots. Olive ridleys move further landward than the leatherback turtles (Agyeman 2008). Turtles, occasionally, in an attempt to locate suitable nesting spots, or after successfully completing nesting, lost their way back to sea. They stray longer on the beach trying to locate their way back to sea. They move to houses, thickets and roads close to the shore and can be poached. Turtles may abandon the nesting process and return to sea if no suitable nesting spots are successfully located, or they sense an imminent danger around them.

Moisture content on the nesting beach differs based on proximity to the sea, river, water table and seasonal rainy pattern. The preferred sandy beaches for turtle nesting are those with a moisture content between 1.5 and 3.0%.

4.2.2 Beach morphodynamics

Sandy beaches in Ghana are highly unstable. Strong waves and erosive forces cause substantial beach losses annually. Flooding during the high rainy season also causes beach loss. Over 1.5 m beach or more is lost annually and this impacts negatively on emerging turtles and their nests (Agyekumhene 2009). Habitat loss through beach erosion is a common phenomenon at the site. This has negatively affected nesting turtles in the selection of nesting sites. High cliffs created as a result of erosion make it difficult for turtles to access the back beach to lay their eggs. Nests are clustered in particular spots which are normally below the high tide line, making them susceptible to erosion and inundation at high tide.

Excessive erosion at some portions of the beach reduces the sand cover of the beach and expose the under layer which is normally clay. Marine turtles nesting at these spots, deposit eggs in shallow nests because they cannot dig further due to the clay underlay. Eggs in such nests are exposed to predators, excessive heat from sun and flood waters. The embryo of sea turtle eggs are killed when they come into contact with water from the sea of excessive rains (Ragotzkie 1959). The incubation process can be interrupted leading to low hatchling success.

4.2.3 High tidal fluctuation

Changes in water tides up to 1.98 m during high tide occur at the site and turtle nests can be inundated. Turtles normally select spots above the higher tidal mark to nest. High cliffs are some of the resultant land marks after erosion by sea waves. Cliffs 1.68 m high along the beach have been recorded at the site. Cliffs impede emerging turtles from accessing suitable nesting sites on the beach.

Olive ridley turtles normally will climb cliffs between 40–50 cm and move as far as 80–120 m above the higher tidal mark to nest. Leatherback and green turtles, much bigger than olive ridleys, can only climb very gentle cliffs and they do not move far from the higher tidal mark to nest.

5. Conservation efforts

Turtles are wholly protected and are in the first schedule (Series B) of the list of species protected in Ghana. Songor Biosphere Reserve combines scientific research, education, law enforcement, co-management and ecotourism to ensure that nesting turtles, their eggs and hatchlings are protected from human and other predators. A traditional conservation method, involving the use of norms, beliefs and a taboo regarding turtles as totem has been an effective conservation strategy in the area. Community-based approaches to conservation of sea turtles have been very effective in conserving the species (Ribson 1994). Collaborating with coastal communities to form a conservation task force and turtle protection volunteer groups have assisted in reducing poaching in areas that are not effectively and regularly monitored and patrolled by the Wildlife Division. Effective conservation education in schools and coastal communities on the species and conservation laws have reduced poaching and promoted information sharing on illegal activities. Promoting ecotourism that provides direct benefits and other linkages to communities has also provided support for collaboration on the protection of turtle species.

6. Conclusion

Sea turtles are an important component of the marine ecosystem. They play vital ecological roles in both the marine and terrestrial environment. Sea turtle populations around the globe have decreased and keep on decreasing due to human activities. In most coastal communities in Ghana there has been drastic decline in the population of sea turtles with possible extinction of some of the species such as loggerhead and hawksbill which once nested on the beaches of Ghana. Although natural factors such as beach erosion and diseases can also cause reduction in the population of turtles, the contribution of these factors are minimal. Also, human activities are causing some of the natural factors to occur at a faster rate.

In Ghana, there have been several efforts both by individuals and groups to help protect sea turtles as an important natural resource. An example is the effort by the Wildlife Division of the Forestry Commission using education, law enforcement and community participation to protect the sea turtles. These efforts have seen a reduction in the activities that caused the sea turtle population to decline.

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Mount Mulanje—A Mountain of Hope!

Le Mont Mulanje: une Montagne D'espoir!

CARL BRUESSOW¹ • MOFFAT KAYEMBE¹

Abstract

Mount Mulanje is a significant mountain environment based around a protected forest reserve in south-eastern Malawi that has been a global biosphere reserve since 2000. The mountain stands 3 000 m high, covers an area of 650 km² and offers a significant forest, water, biodiversity and tourism resource to the local communities and commerce. However, sustainability challenges exist both to the biodiversity and the natural resources from a substantial surrounding population density that struggles to fulfil their daily livelihood needs in this impoverished country. The biosphere reserve approach that makes an attempt to resolve these various dilemmas has been facilitated by the operations of the Mulanje Mountain Conservation Trust (MMCT) since 2002. MMCT has been established as a multi-stakeholder governed organization based upon an endowment trust fund.

A rigorous engagement with the biosphere reserve approach calls for comprehensive stakeholder involvement in local management, research and economic activities. MMCT has facilitated this coordination through its governance and its working operations, and is instrumental in linking the protected area management, local traditional authorities, government agencies, commerce and civil society to develop opportunities and address challenges. The greater community is involved in many conservation and environmental management operations, natural resource management based commercial activities, and social justice initiatives that address local issues. This is enabled by developing local community institutions, assisting collaborative management contracts, initiating resource-based associations and facilitating a wide range of capacity building needs within these emerging local organisations.

Progress in this impoverished area ultimately is based upon the ability to create opportunities for participation of both local communities and commerce in generating substantial livelihood benefits. Prior protection management restricted access to resources and therefore a steady increase in illegal activity developed that was

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soon to threaten the very sustainability of most of the mountain's resources. Mulanje stands near to many other protected areas that have lost their forests, their water resources, their biodiversity assets and are now experiencing climatic challenges too. Controlled access on Mulanje has led to increased economic activity based upon innovative approaches such as fair trade and ecotourism that bring many different stakeholders together to collaborate for the grander goal of biosphere reserve sustainable development.

Key words: Protected area management; governance; endowment funding; partnerships; endemic biodiversity; poverty dilemma

Résumé

Le Mont Mulanje représente un environnement montagnard important, basé autour d'une réserve forestière protégée au sud-est du Malawi, classée réserve de biosphère mondiale depuis 2000. La montagne s'élève à une altitude de 3,000 m, couvrant une superficie de 650 km² et se compose de ressources significatives en termes de forêts, eaux, biodiversité et tourisme pour les communautés locales et le commerce. Cependant, des enjeux liés à la durabilité existent au niveau de la biodiversité et des ressources naturelles en raison d'une densité de population avoisinante substantielle qui se bat pour satisfaire ses besoins quotidiens de subsistance dans ce pays appauvri. L'approche de réserve de biosphère qui tente de résoudre ces divers dilemmes a été facilitée par les opérations du Mulanje Mountain Conservation Trust (MMCT) depuis 2002. Le MMCT a été établi en tant qu'organisation à intervenants multiples, basée sur un fonds fiduciaire de dotation.

Un engagement rigoureux par rapport à l'approche de réserve de biosphère fait appel à une implication profonde des intervenants en matière de gestion locale, de recherche et d'activités économiques. Le MMCT a facilité une telle coordination grâce à sa gouvernance et ses opérations d'exploitation et est instrumental pour connecter la gestion des zones protégées, les autorités locales traditionnelles, les organismes du gouvernement, le commerce et la société civile en vue de développer des opportunités et faire face aux défis. La communauté, dans son sens large, est impliquée dans de nombreuses actions de conservation et de gestion environnementale, d'activités commerciales basées sur la gestion des ressources naturelles et d'initiatives de justice sociale abordant les enjeux locaux. Ces actions sont rendues possibles en développant les institutions communautaires locales, encourageant les contrats de gestion collaborative, lançant des associations basées sur les ressources et facilitant une vaste gamme de besoins de renforcement de capacité avec ces organisations locales émergentes.

En fin de compte, les progrès dans cette région appauvrie reposent sur la capacité à créer des opportunités pour la participation des communautés locales et des entreprises dans la production de revenus de subsistance conséquents. L'organisme de gestion des zones protégées précédent, avait restreint l'accès aux ressources si bien que les activités illégales s'étaient développées progressivement et régulièrement,

menaçant très vite la durabilité même de la plupart des ressources de la montagne. Mulanje se trouve à proximité de nombreuses autres zones protégées qui ont perdu leurs forêts, ressources hydriques, atouts de biodiversité et qui, de plus sont actuellement soumises à des enjeux climatiques. L'accès contrôlé de Mulanje a donné lieu à un élan de l'activité économique basé sur des approches innovantes comme le commerce équitable et l'écotourisme, réunissant plusieurs intervenants différents pour réaliser l'objectif plus large de développement durable de la réserve de biosphère.

Mots-clés: Gestion des zones protégées; gouvernance; financement par dotation; partenariats; biodiversité endémique; dilemme de la pauvreté

1. Introduction

The Mount Mulanje Biosphere Reserve is a significant mountain environment situated in southern Malawi, a small country located in southeast Africa. Malawi is one of the world's most impoverished nations, a consequence of an increasing population with a high density reliant on limited land availability and declining natural resources. The 2011 United Nations Human Development Report lists Malawi as 171 on the global Human Development Index with the remaining 17 nations all either currently in a state of war or having recently concluded strife. Malawi has always been a peaceful nation. The country's landscape is host to rural smallholder farming families who now struggle to achieve a sustainable livelihood for basic subsistence and income generation purposes, and this is further compounded by diminishing access to a range of daily household natural resources. This predicament conflicts with the current national conservation commitment to manage a protected area system that today covers over 20% of available land area.

The country has an emerging multiparty democracy that has been maturing steadily since the termination in 1994 of a long-standing autocracy in effect since independence from the United Kingdom in 1964. Being landlocked, and endowed with limited mining resources and a low level of industrialisation, Malawi has essentially evolved into an agricultural economy that principally exports tobacco, tea, sugar and cotton. A current population at over 14 million on a land area of 95 000 km² translates to one of the higher population densities in Africa. Mulanje District has a density twice the national figure with most people living rural smallholder farming lifestyles on plots of less of 0.3 ha, cultivating subsistence staple crops and suitable cash crops to sustain a relatively simple livelihood. The availability of adequate farmland per family and the maintenance of fertile soils have now become a crisis, upon which the negative impact of unforeseen climate change shocks today accentuates vulnerability to the breakpoint of famine with ease.

Mount Mulanje rises out from the surrounding plains at 500 m above sea level (Dowsett-Lemaire 1988) precipitously to a height of 3 002 m and covers a spatial area of 650 km² (Figure 1). The vegetation varies from the drier Miombo-*Brachystegia* woodlands on the northern leeward slopes to mid-altitude rainforest prevalent along the



Figure 1: *Enhanced satellite view of Mount Mulanje Biosphere Reserve*



Figure 2: *Rainforest slopes of Mount Mulanje*

riverine valleys on the windward southern side (Figure 2). These habitats host an endemic biodiversity estimated to be of over 250 plant and animal species, many of which are yet to be taxonomically described (Chapman 1962, Strugnell 2006). Mt. Mulanje experiences one of the highest rainfall regimes in southern Africa with an annual precipitation of between 2 000–4 000 mm experienced over the watershed heights. Three tribal cultures neighbour the mountain, the Mang'anja, Lomwe and Yao peoples, and they occupy 139 villages within a seven kilometre proximity zone away from the boundary with a population of over 250 000 inhabitants. Most of these villagers use the mountain's resources on a daily basis for a wide variety of household needs.

2. Background

Malawi has an extensive protected areas estate conserving over 20% of its land area for forestry and wildlife management, a challenging commitment where a high rural population density struggles for food security and adequate household resource availability. Mt. Mulanje was recognised early in the colonial period for conservation protection and declared a Forest Reserve in 1927. Managed by the British as a model forestry area, the mountain was well staffed and resourced for the purpose. It is only more recently that its biodiversity assets have gained appreciation with an increased international recognition coming forth from a variety of quarters. Mulanje is recognised as an IUCN Centre of Plant Diversity, an Important Bird Area by Birdlife International (Birdlife International 2012a), consolidated as part of the Afromontane Archipelago Biodiversity Hotspot (Dowsett-Lemaire 1989a), and more recently listed as a Key Biodiversity Area (Birdlife International 2012b, Dowsett-Lemaire 1989b).

The process to compile the nomination for the listing of Mt. Mulanje as a global biosphere reserve began in the mid-1990s with the financial and technical assistance of UNESCO country office. A team of scientists led the process and submitted the completed dossier to the UNESCO Man and Biosphere (MAB) Programme for consideration and the award of status was granted in April 2000. Mt. Mulanje was one of the earlier biosphere reserves to be established in Africa and as such reflects the thinking of the time as the boundaries are largely commensurate with those of the forest reserve itself (Figure 3). This status has given Mt. Mulanje the increased conservation attention it deserves and an opportunity for innovative activities to be undertaken.

Malawi has over 80 forest reserves with no differential in status, most of which were originally established as watershed conservation areas and many today have sadly been deforested by the resource-poor communities surrounding them. Encroachment for settlement or crop farming is also today a common scenario. Management is a complex issue with such population pressure and competing stakeholders. The mountain is situated across an international frontier with Mozambique, two districts and six traditional authority areas. This cross-border and cross-boundary situation can present many dilemmas where coordination between nation states, district government and traditional authorities requires a complex bureaucratic arrangement to achieve a workable management situation.

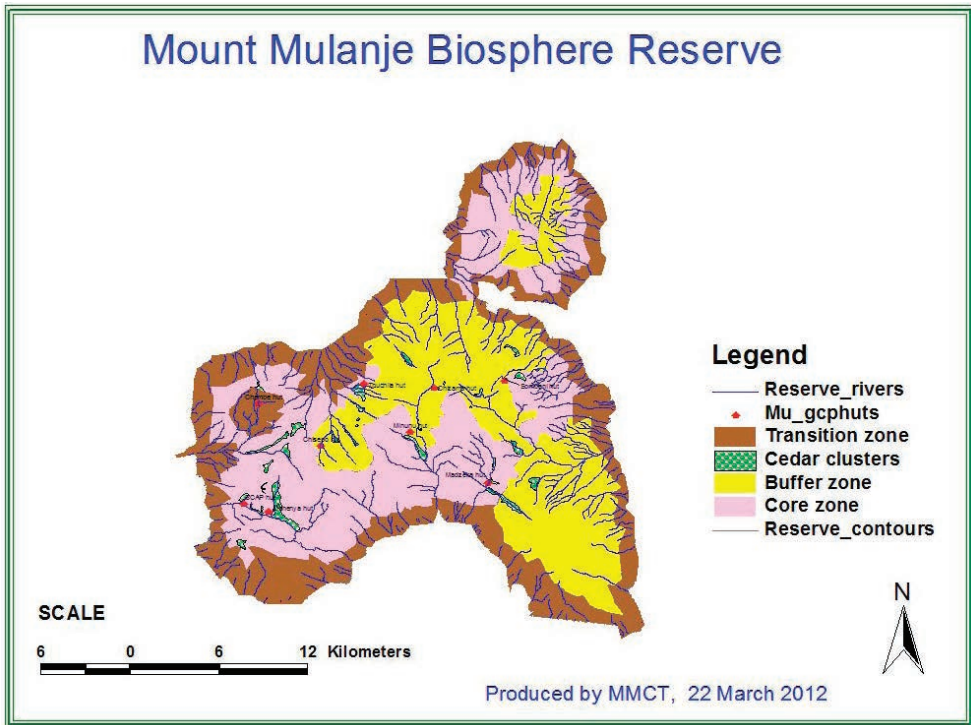


Figure 3: Mount Mulanje Biosphere Reserve zonation

The UNESCO MAB Programme presents a unique opportunity for Mt. Mulanje. Biosphere reserves are specifically proclaimed areas of global significance deserving of this status for a variety of reasons and in Africa, many are based upon national protected areas of priority ecological significance. The biosphere reserve paradigm advocates for a sustainable development approach within the spatial zones delineated outside the core conservation zone and to realise this potential requires the involvement of many organisations and the participation of the local citizenry.

3. The quandary

Poverty is generally understood to be a state of scarcity, a context where there is a deficiency of local resources, services and capacity. Mulanje and Phalombe districts are statistically two of the 'poorest' districts in Malawi, compounded by the situation of being within the world's poorest peaceful nation. This circumstance begs the question of how does impoverishment prevail where rainfall is high, the soils adequately fertile, water is available for irrigation, urban markets are nearby, and where there has been peace for a century since slavery was ended. Poverty exists here seemingly within a state of abundance. A simplistic understanding to this issue is that there are malfunctions in the supply-chain regimes and service facilities necessary to motivate a working economic model. We can see that poverty here prevails as there are unsustainable socio-economic

factors impacting on the market demand and supply systems. There would appear to have been little historical cooperation between the state, its own agencies, commerce and local communities to determine the local potential and identify relevant opportunities to build the synergies to benefit each party in a sustainable development approach.

Forest reserves in Malawi are managed by a legally mandated government authority, the Department of Forestry, once well-organised and resourced to undertake its responsibilities, but now only a shadow of its past competency. This government agency has been saddled with the management of 80 such reserves, not due necessarily to the significance of their inherent forest resource, but due to their substantial watershed catchment potential. The fact that these forestry conservation areas have no prioritisation leads to a difficult dilemma of determining appropriate prioritisation for management attention and budgeting. The parallel wildlife sector in Malawi has a two-tier system: a priority national parks system conserving the more unique biodiversity areas; and a secondary wildlife reserve system that in most respects just duplicates the priority tier's resources in less accessible situations or attractive surroundings. Recognising that some forest reserves have significant biodiversity also presents a difficult predicament to the management authority as it does not have the specific capacity to conserve the unique ecology within its estate. The department has rather had an institutional responsibility to provide for the timber needs of the nation and this capability has been achieved by eradicating large areas of indigenous woodland or forest to establish industrial exotic timber production plantations.

Over time, a reorientation of government budgetary expenditure has largely disabled the effectiveness of the management capacity of the Department of Forestry. The stipulations of central treasury's paradigmatical shift through a structural adjustment programme, the governmental decentralisation process and the HIPC (highly-indebted poor country) agenda have rendered the department minimal budgetary support today. The consequence is that these protected areas have now become vulnerable to illegal encroachment and exploitation.

A new forest reserve management arrangement is now required that reflects the significance of the watershed value and other natural resource assets, the responsibility of managing the resident unique ecology and endemic biodiversity, and the rigorous involvement of the neighbouring communities in more concerted participatory management action. New forestry policy allows for collaborative management agreements and protected area resource utilisation so this should be implemented on a substantive basis. At Mt. Mulanje, the ideal solution is to create a grand social construct between the natural resource sector management agencies, support organisations, commerce, the research fraternity, neighbouring communities and public stakeholder interests to realise the mountain's potential. That social construct requires a common platform for shared decision-making and also the opportunity for the broader community to access benefits in an exchange for responsibility towards the stewardship of those resources.

The Mulanje Mountain Conservation Trust (MMCT) was created in the 1990s by concerned local conservationists to assist the improved management of Mt. Mulanje

in recognition of the Department of Forestry's under-financed and under-staffed situation. MMCT's capacity was substantially assisted in 2002 by a World Bank project and a USD5.5 million grant from the Global Environment Facility to establish an endowment fund that would assure continued financing for Mt. Mulanje priority needs. The skills capacity of the Department of Forestry, local agencies and neighbouring communities would primarily benefit. Appropriate guidance of the Trust's strategy and operational action was established by comprehensive stakeholder governance within the organisation that does reflect the significant resource sectors and community constituencies of the local Mulanje context.

The Department of Forestry has the mandated government authority to manage the Mulanje Mountain Forest Reserve and they are assisted by the MMCT that has the responsibility to assist the financing of environmental and social projects within the broader Mt. Mulanje Biosphere Reserve. The Trust works in partnership with the many community, government, civil society and commercial organisations.

MMCT has been operational now for a decade rendering financial support annually in excess of USD1 million to facilitate action that has realised many achievements but fundamental challenges still remain. Management largely remains the sole function of the Department of Forestry and this has limited access and opportunity to develop the reserve's assets. Understanding the externality of MMCT's position, and the apparent need for a consolidated management approach uniting stakeholders' expertise and capacities, there has been efforts to establish a broader management arrangement. Collaborative management between village communities and the Department of Forestry has developed slowly and a Local Forest Management Board is now in place to represent broad community interests. However, a more inclusive arrangement with other national agencies and support organisations is yet to materialise, and the absence of this is determined to be the bottleneck to realising further potential. With the biosphere reserve sustainable development framework in place on one side and a recognition that more comprehensive participation motivates increased responsibility, the mountain setting has become an ideal context to catalyse more stakeholder involvement in management and utilisation activities. The case for a public-private partnership management arrangement to be established within a multi-stakeholder mountain authority with delegated authority and mandated action is now apparent.

4. Stakeholder involvement

There is clearly a mountainful of opportunities available for both local economic benefit and conservation improvement. This potential requires the concerted involvement of appropriate organisations and local community groups to work within the sustainable development framework to achieve the beneficial products. Where poverty prevails as it does in Mulanje, there is an urgency to initiate ventures within working partnerships that ensure that there is adequate regulation of the activities. The following are illustrative of the key stakeholder partnerships that are developing around valuable opportunities.

4.1 Government sector authorities

The mountain, as stated previously, has a diversity of significant natural resources that does deserve additional government sector management. The biodiversity, tourism, water and energy assets in particular all require additional sector expertise and attention. The opportunity exists to realise substantial benefits from these sectors to the stricken local economy and concurrently assist the mountain's management through the implementation of an innovative payments system for ecosystem services.

The water resource of Mt. Mulanje is substantial (WWF 2012) with nine perennial rivers originating here and these supply water for household use, irrigation, hydropower and fish-farming activities (Figure 4). Over 300 000 people enjoy clean uncontaminated piped water daily through gravity-fed systems on the mountain. There is an increase to both village and estate irrigation and hydropower production and these initiatives can be scaled up to involve a substantial proportion of the local community with significant positive benefits. This great economic value does call for wise water management to ensure continued supply regimes, plan for future needs and to defuse conflicting water demands. The sector policy recommends that significant catchments should have a water catchment management authority prevailing over the resource usage. These modalities should be put into place to enable this and to realise an income stream for an improvement to catchment conservation.

A recently improved road network, better accommodation facilities (Figure 5) and increased marketing has seen a boost to the local tourism industry and more visitors are attracted to the area. Cooperation between the Malawi Government Department of Tourism and the Trust has greatly assisted in developing the tourism sector on and around the mountain. The main focus of this has been to set



Figure 4: Natural stream and waterfall on Mount Mulanje



Figure 5: Mountain cottage constructed from Mulanje Cedar timber

up the InfoMulanje office, a tourism information and reservations service, that eases the dilemmas often encountered by visitors when organising a trip on an unfamiliar route. The mountain trails and cottage network has been greatly improved and many local entrepreneurs have invested in developing tourism facilities around the mountain, their interests consolidated through the formation of the Tourism Association of Mt. Mulanje. Mountains enable ecotourism with relative ease and this has assisted the development of the Mt. Mulanje Guides and Porters Association to provide services to tourists wishing to hike the area.

The mountain has enormous potential to assist local energy requirements both for hydro-electricity generation and fuelwood production. The recently established Malawi Energy Regulatory Authority has the mandate to enable independent power producers to become established and in that vein MMCT has collaborated with the Department of Energy to set up the Mulanje Renewable Energy Agency (MuREA) for this work. The Mulanje Electricity Generation Agency is currently being formed to commercially sell electricity within the local village communities. On the biomass side, MuREA has attracted both Clean Development Mechanism (CDM) Gold Standard and other financial support to lead efficiency technology research and development in Africa and usage locally.

The plant diversity of the mountain and surrounds is significant according to Chapman (1962, 1991, 1994) and Strugnell (2006) and the analysis of traditional use and potential innovative uses is being undertaken through a bioprospecting survey involving the National Herbarium and Botanic Gardens, the Forestry Research Institute and the Chancellor College Biology Department. The objective is to identify and secure sustainable harvesting of a number of plants for the extraction of pharmaceutical and cosmeceutical purposes.

4.2 Local government

There is a decentralisation process underway in Malawi, however uncommitted and intermittent it might be perceived to be. Historically, the pre- and early post-independence period saw district government responsible for providing a higher level of services and raising local taxes and income to finance this. When the then autocratic regime disbanded this extended local authority due to mismanagement concerns, Mulanje was the lone district in the country able to operate with a fiscal surplus. Mt. Mulanje covers a substantial area of the two districts of Mulanje and Phalombe, and it is anticipated that these councils will seek to develop local revenue opportunities from the mountain in future. These district authorities would seek benefits from the mountain to assist their operations and likewise the mountain would benefit from district-level regulations to improve governance. The limitation to date has been a capacity one, as councillors have not been elected for over five years and the council staffing remains at minimalistic level in comparison with local government service delivery. Local regulations could limit the negative impacts and compliment sustainable development initiatives. For example, a local concern is the increasing number of dogs in the district that are causing human

rabies fatalities but are also used as the primary tool in illegal hunting activities on the mountain.

4.3 Local communities

Natural resource management in Malawi has until recently been the sole responsibility of the government. However, recently in recognition of the local community resource use regimes and the limited capacity on the ground of the government sector agencies, there has been a steady adoption of Community-Based Natural Resource Management principles and practices in national policy. Six collaborative management contracts that have been comprehensively developed between neighbouring villages and the Department of Forestry have now been signed to allow for joint management and use of the local natural resources, and further contracts are now underway. In line with the forestry policy, a Mulanje Local Forest Management Board has been established to assist forest reserve management and a strategic plan developed to guide their activities.

Access to the forest reserve has historically been allowed on a permit fee basis to the neighbouring communities to harvest a wide range of resources for local household use. There is local harvesting of firewood (dead tree branches), bamboo, fruit, mushrooms, fish, medicinal plants, and a wide range of other household resources (Figure 6). However, there has not been an assessment to date of how the constant resource harvesting has affected the status of preferred resources or the ecology as a whole. The controversial management and leadership situation within the Department of Forestry realises a substantial increase in corruption and illegal harvesting amongst the very staff that are responsible for management.

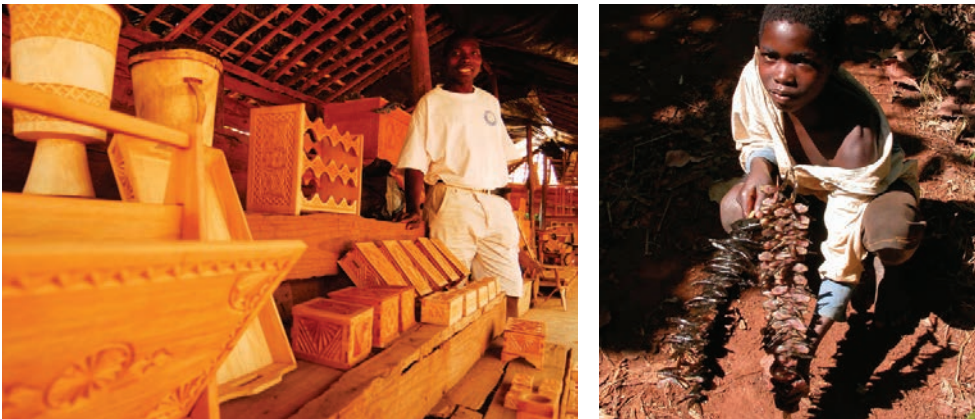


Figure 6: Mulanje Cedar crafts are globally unique (left); Mulanje river catfish are endemic (right)

4.4 Commerce

Opportunities for the commercial development of tourism, plantation and natural products are very attractive and interest from several companies has been expressed. The opening up for commercial investment however today remains limited and this would

appear to be the de-facto government policy on the mountain. Whilst the Department of Geological Surveys can approve and motivate mining exploration on the mountain with ease, there has been no commercial development approved of the more sustainable tourism, water and energy resources within the past decade. Tourism accommodation and activity investment projects have been proposed within the reserve boundaries, but no further progress has been achieved to date. A timber plantation co-management contract has been granted to Raiply Ltd. for the purposes of purchasing eucalyptus poles from the Nanchidwe plantation on the southeast slopes of the mountain, but there are over 3 000 ha of other plantation zoned areas that require reinvestment and commercial management. However, there has been steady economic development taking place around the mountain with the involvement of local commerce and communities.

The beekeeping story started with two pilot user group activities with subsidised training and equipment in 2005 and has grown exponentially on its own success to now involve over 2 500 beekeepers, within 300 clubs spatially arranged within eleven zones around the mountain. The Sapitwa Beekeepers Association was set up to provide an institution framework to strategically grow the local industry, coordinate and consolidate the clubs and beekeepers, and to collaborate with supply chain organisations for sale of honey to the retail market. The price of honey in Malawi is higher than the international rates as local demand is strong, and the mountain's high rainfall and diverse floral kingdom is a good basis for expanding this industry further. Beekeepers are keen to plant good bee-forage trees and there are intentions to soon place hives within the forest reserves in co-management areas that will increase local vigilance against fires and illegal resource harvesters.

Mt. Mulanje, as the highest mountain in tropical southern Africa, obviously offers an attractive tourism destination with its rugged landscape, panoramic vistas and unique biodiversity. There are ten cottages in a variety of locations across the mountain available for tourism overnight accommodation (Figure 7) linked by an impressive network of paths and interspersed by a selection of over 25 peaks to climb and many river pools in which to cool off. The Mt. Mulanje hiking holiday is the quintessential Malawian ecotourism experience with a trip usually led by a local guide and numerous others offering portering and catering assistance. Mt. Mulanje can cater for additional tourists with the existing facilities, therefore increased marketing and publicity are now being financed to motivate this interest. A steady stream of media articles and increased ecological awareness are having good results with over 5 000 visitors hiking the mountain this past year through the main entry gate. Many tourists use guides and porters, purchase local



Figure 7: *Hikers high altitude accommodation at Chisepo Hut*

provisions and crafts, and use local transport and accommodation. In order to cater for the increasing tourism market, there have been an encouraging number of local commercial investments in new lodges and restaurants.

Good rainfall and soils have enabled a rich horticultural industry in Mulanje. Mulanje is the historic home to tea in Africa and thirteen estates are situated on the southeast slopes that work closely to conserve the mountain. Many are working with MMCT within both fair trade and Rainforest Alliance certification systems and this opportunity has been extended to 13 000 out-growers within two associations. MMCT assists the additional production of over 2 million tea seedlings for out-grower purposes. A further fair trade scheme under MMCT facilitation supports macadamia nut production in cooperation with Twin Trading in the United Kingdom. Mulanje is home to Mulanje Peak Foods, a unique canning company that is reliant on smallholder crop products and Nali Limited, producers of Africa's foremost hot sauce. The latter now produces bottled honey from over 5 tonnes of product purchased from beekeepers around the mountain. These companies are being assisted through increased production from small-scale irrigation schemes and improved quality from better seed. MMCT has traditionally distributed large quantities of tree seedlings and one intended output is to develop Mulanje as a leading producer of a wide range of fruits and nuts for the local market.

4.5 Research

Research is both an important activity for understanding the ecology of the mountain and also of understanding local social attitudes and interests. Many different academic institutions and research bodies work on and around the mountain that are fully or partly supported by the Trust. Whilst the scientific research on the mountain informs us to be more appropriate in our management activities, the social research creates an understanding of how the local thinking is responding to the initiatives being undertaken. These research projects are both financially supported and facilitated by MMCT in accordance with an overall research plan, and the increasing number of international agencies involved partners to build capacity with local institutions to enable long-term sustainability.

4.6 Cultural and spiritual aspects

Mt. Mulanje has generated significant respect, spiritual beliefs and myths amongst the local communities. As such this similarity and mutuality within the three tribal cultures forms a grand social construct of the mountain as much more than a physical object. In tribute to this rich intangible heritage, there is an ongoing bid to submit Mt. Mulanje as a cultural World Heritage Site (Odendaal &



Figure 8: *Sapitwa Peak at 3 002 m above sea level is the highest peak on Mount Mulanje*

Steenkamp 2012, Figure 8). A cultural management plan and programme is being developed that will serve to reinvigorate the traditional confidences towards this heritage in a positive light, and many institutions and local bodies will be enabled to develop and restore local heritage and shrines.

4.7 Environmental action

A major focus of the work of MMCT is to enable the availability of a variety of capacity building initiatives and a substantial part of this involves the improvement of environmental knowledge in the area around the mountain. Schools and the youth are a major focus and to achieve this, MMCT has assisted the establishment of a local branch of the principal environmental organisation, the Wildlife and Environmental Society of Malawi (WESM). WESM has a long-standing leadership in the country of implementing a wide range of environmental education programmes and has set up a vast network of school-based wildlife and environmental clubs which it supports with activities, resources and visits to protected areas. This support has now been made available through this new branch to 83 registered school clubs around the mountain with a significant number of local youths now hiking the mountain to appreciate its ecology, participating in local environmental competitions, celebrations and project activities. There is now a growing appreciation from the youth of local environmental considerations and concerns, and their commitment to activities being supported around the mountain increases year on year. An outcome of this has been the contracting on a commercial basis of three youth groups to carry out management work upon the mountain on a professional basis.

5. Challenges

5.1 Resistance to innovation

The expansion of sustainable economic activities can improve the ecological state of Mt. Mulanje and provide livelihood opportunities for the growing population. However, these developments would need to be well designed, regulated and monitored through the involvement of other government departments and undertaken by well-resourced and capable companies. This will require the Department of Forestry to share protected area and resource management decision-making and there could be resistance to this.

5.2 Neglect of the biodiversity priority

Globally, the most significant aspect of Mt. Mulanje is the presence of unique plant and animal species that do not inhabit any other place outside the mountain (Chapman 1994, White 1983, White *et al.* 2001) and this interest is reflected in the international donor support made available to complement government's conservation effort. The promotion of alternative livelihood economic opportunities must be encouraged where this does not conflict with conservation action, but this approach cannot in itself provide a panacea to resolve the many challenges faced on Mt. Mulanje. There is a need to ensure

that there is adequate attention focused on the state of the ecology and the biodiversity health, especially when extractive industries are considering exploitation of resources.

5.3 Competing resource use

The prevalence of conflicting economic interests on Mt. Mulanje requires resolution to secure long-term planning for the sustainable use of the valuable natural resources. The mining interest in various minerals required decision-making attention of government to develop a position in the national and local interest. The current scenario where the extractive industry is being allowed access alongside the implementation of significant conservation action creates confusion and continues a long-standing suspicion of government's ultimate intent. The mountain's World Heritage Site nomination process is also placed in jeopardy.

5.4 Illegal resource exploitation

The involvement of local resource users in more comprehensive economic activity on the mountain has not been achieved to an adequate level and a consequence of this is that there is significant harvesting of the forest resources for timber and charcoal production. The survival of the most important endemic species, the Mulanje Cedar (*Widdringtonia whyteii*, WWF 2012), is at stake particularly as this tree provides an ideal timber for boat building and speciality construction purposes (Figure 9). Typical law enforcement has not effectively countered this threat and there is a need to involve the broader communities in sustainable utilisation approaches.



Figure 9: Illegal destruction of the Mulanje Cedar forests

5.5 Financing the new management arrangement

Ordinarily, one of the major obstacles to enabling a new approach with potentially significant cost implications would be the sourcing of the necessary funds. However, in this situation, the presence of MMCT presents this biosphere reserve with a supportive endowment fund to ensure that the required continuity and innovation can be effectively and adequately financed. The demands for financial support on MMCT will continue to increase and there is a need to ensure that it is adequately endowed and financed to undertake the local priorities.

6. *The way forward*

Progress can be made for increased stakeholder involvement on numerous levels once the positive cooperation of the Department of Forestry is gained. The momentum to seek the public-private partnership management arrangement needs to be vigorously renewed to promote this innovative approach to a multi-sectoral and multi-stakeholder based system. Opportunely, parliament has recently passed the appropriate legislation to enable this arrangement to now be formally developed.

Today, the Mt. Mulanje Biosphere Reserve has an overdue obligatory requirement to complete its ten-year periodic review. This process should be one of reflection and redesign both of the boundaries of the delineated zones and the levels of public participation. New challenges such as climate change require rigorous participation as the mountain's weather has many extremes that require mitigation and disaster plans must be prepared for public response to the increasing number of flash-floods.

Sustainable development is a fundamental concept, whereby on one side, careful economic opportunities are motivated to fruition for the benefit of, on the other side, a responsible local population in need of those resources. Seeking a continued exploitation of the renewable resources that nature provides for our livelihood needs cannot be an endless expectation, as our understanding of sustainability infers that there are limits to this. The increasing population around the mountain has to balance itself carefully against its resource requirements. The issues addressed by family planning do require more attention.

Mt. Mulanje will gain great status from the potential award of World Heritage Site status, as not only will this achievement attract the attention of those elsewhere to visit and admire this place, but it would also serve to realise local pride and respect of the mountain given that international recognition. However, the fundamental framework to achieve the realisation of the many local hopes, aims and expectations lie in the opportunities that are created through the sustainable development approach of the global biosphere reserve status.

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Stakeholders' Participation in the Creation of the Proposed Niimi Biosphere Reserve, The Gambia

Participation des Parties Prenantes dans la Creation du Projet de Reserve de Biosphere de Niimi, en Gambie

ABDOULIE SAWO¹

Abstract

The Gambia, located in West Africa, is the smallest country on mainland Africa. Although it is the fourth most populated country in Africa, the villages in the North Division are not so extensively populated. A new biosphere reserve is proposed in this region, incorporating the Niimi National Park as the primary core area. The Niimi Biosphere Reserve will be the first UNESCO designated biosphere reserve in The Gambia.

The Niimi region is an area of biodiversity wealth, including numerous bird and fish species and valuable mangrove stands. The Niimi Biosphere Reserve will cover approximately 132 000 ha, share a border with Senegal and will have the Gambia River as its southern boundary. The land area consists mainly of traditional/communally owned, private and co-managed land. Agriculture, settlements, livestock, and traditional woodlots are the main land uses.

Stakeholder participation for the Niimi Biosphere Reserve started in 2002 when a Technical Advisory Committee was set up in preparation of the more detailed biosphere reserve process that started in 2005. However, the smooth operation of stakeholder committees currently suffers from insufficient financial resources. A collaborative management agreement will be responsible for managing the Niimi Biosphere Reserve. The UNESCO nomination for the proposed biosphere reserve is planned to be completed soon.

Key words: Gambia; Niimi; biosphere reserve; stakeholders; participation

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Resume

La Gambie, située en Afrique de l'Ouest est le plus petit pays du continent africain. Malgré sa densité de population qui la place en quatrième position en Afrique, les villages dans la Division du Nord ne sont pas aussi peuplés. Une nouvelle réserve de biosphère incorporant le Parc national de Niimi en tant que zone centrale principale, est proposée. La Réserve de biosphère de Niimi sera la première réserve de ce type désignée par l'UNESCO en Gambie.

La région de Niimi est une zone riche en biodiversité et comprenant de nombreuses espèces d'oiseaux et de poissons ainsi que des peuplements rares de palétuviers. La réserve de biosphère de Niimi couvrira environ 132 000 ha, partageant une frontière avec le Sénégal, avec le fleuve Gambie comme frontière au sud. La zone terrestre comprend principalement des propriétés foncières traditionnelles/communes, privées et cogérées. L'usage de la terre est principalement destiné à l'agriculture, aux implantations villageoises, à l'élevage de bétail et aux boisés traditionnels.

La participation des parties prenantes pour la Réserve de biosphère de Niimi a commencé en 2002 lors de la mise en place d'un comité consultatif technique en préparation du processus plus détaillé de la réserve de biosphère qui a été lancé en 2005. Cependant, le bon fonctionnement des comités de parties prenantes est en train de souffrir d'un manque de ressources financières. Un accord de gestion collaborative sera chargé de la gestion de la Réserve de biosphère de Niimi. Il est prévu que la nomination de l'UNESCO pour le projet de réserve de biosphère soit achevée bientôt.

Mots-clés: Gambie; Niimi; réserve de biosphère; parties prenantes; participation

1. Background

The Gambia, located in West Africa, is the smallest country on mainland Africa (Figure 1). The country covers an area of 11 295 km² with an estimated population of 1.7 million. It is a very small and narrow country whose borders mirror the meandering Gambia River. The Niimi National Park occupies the coastal strip of The Gambia north of the river. The park is approximately 4 940 ha in extent. Apart from being an important fish breeding ground, it constitutes one of the last untouched mangrove stands on the West African Coast north of the equator (Niimi National Park 2012).

The proposed Niimi Biosphere Reserve (NBR) will be the first UNESCO designated biosphere reserve in The Gambia. The NBR covers an estimated area of 131 750 ha, resembling a peninsula. It includes two National Parks, two State Forests, and several Community Managed Forests. The NBR is located in West Gambia, between latitudes 13°31' and 13°59'N and longitudes 16°56' to 16°05'W.

The biosphere reserve process began in early 2005, funded by the International Union for Conservation of Nature (IUCN) through its office in Dakar. The funding followed



Figure 1: Location of The Gambia in West Africa, showing the capital Banjul
 (<http://commons.wikimedia.org/wiki/File:Gambia-map-political.jpg>)

the launch of the creation of Niimi–Saloum Transboundary Biosphere Reserve between Senegal and The Gambia to demonstrate methods, tools, approaches and techniques for conservation and sustainable development. UNESCO however recommended for the Niimi Biosphere Reserve to be created first before supporting the two states in the creation and management of the transboundary biosphere reserve.

The area includes a World Heritage Site, the home of renowned slave Kunta Kinte that attracts many tourists.

The population living within the NBR area is about 87 077 (2003 census), representing approximately 6.5% of the total population of The Gambia. This population is distributed between the following three districts as follows: Lower Niimi 44 611, Upper Niimi 24 595 and Jokadu 17 871 (Figure 2). The area is covered by a homogeneous settlement and most of the land is used for agricultural purposes. Although The Gambia

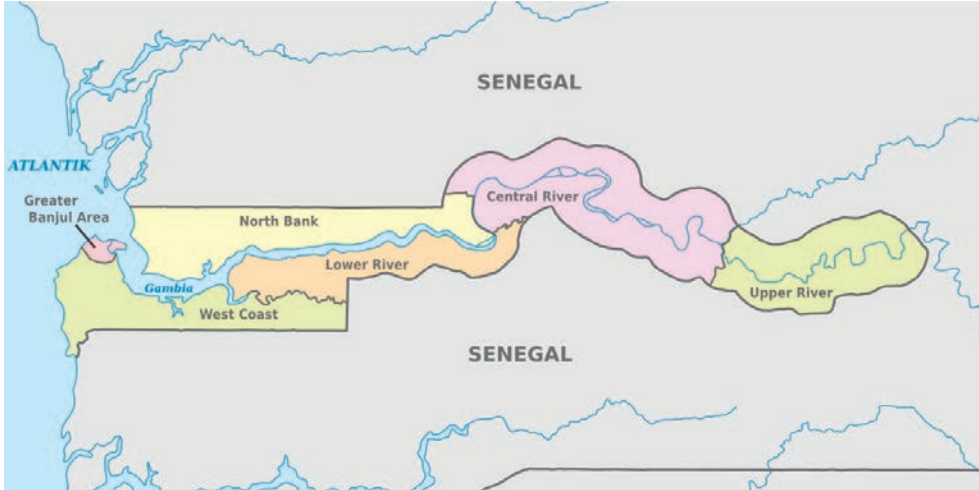


Figure 2a: Divisions of the Gambia

(http://commons.wikimedia.org/wiki/File:Gambia,_administrative_divisions-de-colored.svg)

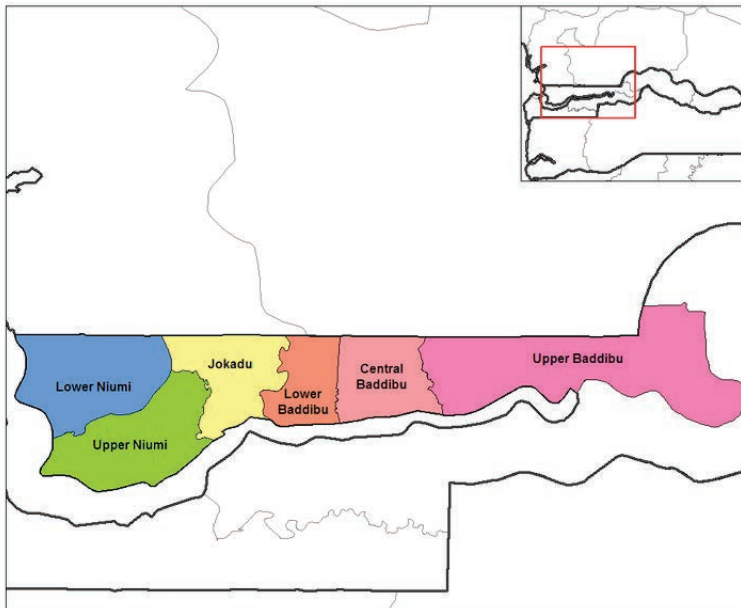


Figure 2b: Districts of the North Bank Region

(http://en.wikipedia.org/wiki/File:North_Bank_districts.png#filelinks)

is known as the fourth most densely populated country in Africa, the existing villages within the NBR are not very extensive.

2. Description of the Niumi Biosphere Reserve

The three districts within the NBR are bordered in the north by the frontier line between The Gambia and Senegal and in the south by the Gambia River (Figure 1). The proposed east and south limits of the NBR are respectively Miniminyang Bolon and the Gambia River which is the last large estuary in West Africa that is free from major human disturbance (Simier *et al.* 2006). In a study of fish populations, about 70 species of fish were identified within the Gambia River system, most of which are of commercial significance (Albaret *et al.* 2004). The estuary of the Gambia River has a decreasing salinity gradient from downstream to upstream (Albaret *et al.* 2004). The coast, the shores and tributaries (bolongs) of the river in the NBR area are mainly covered by mangroves; while downstream they are dotted with red steep limestone rocks, covered by tropical forests and open woodland savannah along the newly constructed and improved road from Barra to Kerewan.

One of the official core areas of the NBR is the Niumi National Park which was listed as a Ramsar site in October 2008 and adjoins Senegal's Delta du Saloum Ramsar site (listed in 1984). Collaborative management arrangements between the two countries are being formalized. The Niumi Ramsar site occupies the coastal strip of The Gambia north of the Gambia River. It constitutes one of the last untouched mangrove stands on the West African Coast north of the equator (Gambia 2011). The NBR would be a continuation of the Delta du Saloum Biosphere Reserve in Senegal (designated in 1980) as the two shares the same ecological entity.

The NBR will share a border with Senegal and will have the Gambia River as its southern boundary (Figure 3). The NBR will include the three zoning elements according to UNESCO's Seville Strategy (UNESCO 1996), namely core areas, buffer zones and a transition zone (Figure 4). Details of the areas included within the core, buffer and transition zones of the NBR is provided in Table 1.

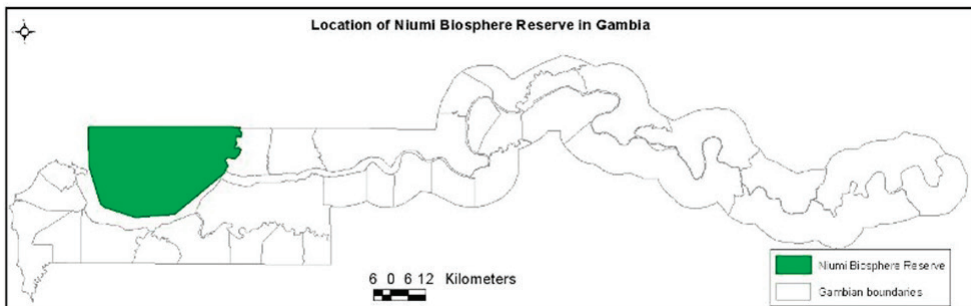


Figure 3: Location of Niumi Biosphere Reserve in The Gambia

Table 1: Areas incorporated as the core, buffer and transition zones of Niimi Biosphere Reserve

	<i>Niimi National Park</i>	<i>Lohen State Forest</i>	<i>Kumadi State Forest</i>
Core zone	7 758 ha	101.82 ha	314.44 ha
Buffer zone	Total 4 702 ha, of which 2 619 ha is terrestrial and 2 083 ha is marine	1 312 ha	Total 3 637 ha, of which 3 209 ha is terrestrial and 428 ha is marine
Delimitation of buffer zone	A buffer zone of 1.5 km wide around NNP on West, South, North/East; between Lewna and Bara the limit of buffer zone is the new main road.	North: Footpath between Sam Njoben and Ndugu Charen. East/North East: Footpath between Sam Njoben, Mbulum and Chamen. West: Footpath between Ndugu Charen and Samba kalla. South: The main road.	North: Footpath between Memmeh and Tambana Karantaba, the secondary road between Tambana Karantaba and Bakang, and the footpath between Bakand and Samakung Tenda. East, West and South: The water body (natural limit.)
Transition zone	The total area of transition zone is estimated to 113 924 ha. All other protected areas such as community forest, protected marine area and remaining forest, are included in the transition zone. The transition zone covers almost all types of habitats found in NBR therefore it offers opportunities to implement research, development and conservation pilot projects that take into account all environmental issues of Niimi Biosphere Reserve.		

Land status and lack of management are two important factors in biodiversity conservation and land degradation. The land area of the NBR consists mainly of traditional/commonly owned, private and co-managed land. Agriculture, settlements, livestock, and traditional woodlots are the main land uses. A system of decentralization has recently deepened through the establishment of socio-technical bodies and counsellors with the responsibility of conducting local development.

2.1 Biodiversity conservation

The need for the conservation and sustainable use of biodiversity and environmental protection in general, was not a high priority for The Gambia government until the early 1970s when the country was faced with serious drought coupled with increasing human population pressure. Hitherto, the country was still covered with vast areas of closed

canopy forests with healthy wildlife habitats supporting numerous wildlife species. The level of natural resource destruction was insignificant as the human population was very low. The population was able to satisfy their domestic needs from the environment and its resources without necessarily destroying it.

However, by the mid-1970s the situation started to change. By 1977 the Government had started giving serious attention to environmental issues, and biodiversity in particular. Environmental policies were developed and some departments responsible for Natural Resource Management and conservation were strengthened. These were the driving forces behind the establishment of formal protected areas, including national parks, nature reserves, state forests and community forests.

Up to the present, a total of seven protected areas have been established in The Gambia. The NBR has benefitted from biodiversity conservation efforts of the Gambian government through the inclusion of the Niimi National Park as the largest core area (Figure 4).

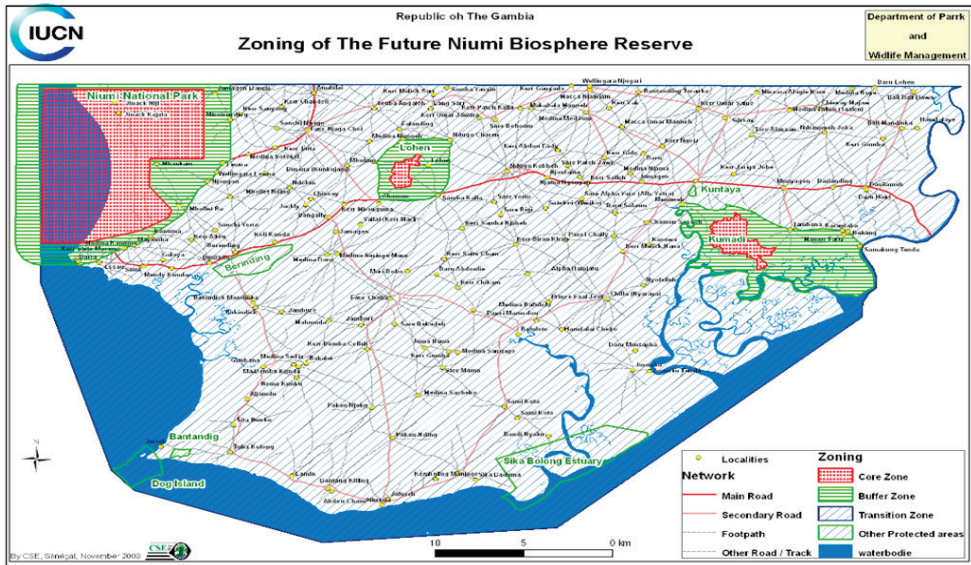


Figure 4: Zoning of Niimi Biosphere Reserve

A number of endangered species are found in the Gambia River estuary, including the West African manatee (*Trichechus senegalensis*), the Western Red Colobus (*Ptilocolobus badius temminckii*), tortoise (*Kinixys belliana*) and the Nile crocodile (*Crocodylus niloticus*) (Gambia-Senegal Sustainable Fisheries Project 2009). The area of the NBR houses a large number of resident bird species and is an important shelter for many Western Palearctic migrants (Barlow & Wacher 1997). At least two species of dolphin occur in the area, namely the Atlantic hump-backed dolphin (*Sousa teuszii*) and the Bottlenose dolphin (*Tursiops truncatus*) (Emms & Barnett 2006).

There are eight listed protected areas in Niimi Biosphere Reserve with official boundaries (Table 2) including a National Park, state forests, and community forests

enhancing the protection of terrestrial and aquatic species and habitats of the biosphere reserve (Figure 5). Currently a new protected area is on the verge of completion (proposed Jokadu National Park— Table 2) and more community protected areas have been identified for future protection.

Table 2: List of protected areas within Niumi Biosphere Reserve

Name of Protected Area	Surface area
1. Berending Community Forest	489.1 ha
2. Niumi National Park	7 758.72 ha
3. Bantanding Community Forest	46.28 ha
4. Kuntaya Community Forest	20.15 ha
5. Bankindik Community Forest	43.88 ha
6. Kumadi State Forest	595.707 ha
7. Lohen State Forest	201.292 ha
8. Kasewa State Forest	155.7 ha
9. Proposed Jokadu National Park	15 028.0 ha



Figure 5: Terrestrial Area within Niumi Biosphere Reserve

3. Economic development

The area of the NBR has a high potential for ecotourism where the available natural resources are used for sustaining the livelihood of the common people. Such activities and attractions include sport tourism such as sport fishing, boat cruising, dolphin watching, and bird watching. Sites of interest for historical tourism include the slave house Juffureh, Albreda, James Island, and the 19th century Fort Bullen. Other tourism activities exist in the form of root home-coming festivals, cultural-based tourism, Berending crocodile pool, traditional music and dance performances that are conducted by local people. In addition there are proposed environmentally-friendly programmes such as village banking and honey extraction which are to be implemented soon.

Tourism in The Gambia has remained mainly in mass form, dominated by working class Europeans looking for a respite from the freezing winters of Europe. Consequently the Gambian beaches receive the bulk of tourists visiting the country. New forms of tourism are actively being encouraged including 'bush safari' excursions, dolphin and bird watching and other forms of ecotourism experiences. The NBR is a unique area where indigenous forests meet the beach. The marine section of the NBR and estuarine areas are state owned and main economic activities, still focusing more on sustaining livelihoods than attracting visitors, include artisanal fishing, transportation related to off-shore oil prospection, rice cultivation, mangrove forest product harvesting and salt mining activities.

Some tourist lodges are available, although most need a lot of improvement in order to attract foreign tourists. In some places like Kanuma, local communities entertain tourists with traditional music and dance. In return, tourists donate some money to the community that is used for community development. A skills-training center for 'tie and dye' activities was constructed by a tourist philanthropist for the villages, especially for women.

Forest products and services play an important role in Gambian livelihoods. Therefore an economic opportunity for the NBR exists in the form of the Reduced Emissions from Deforestation and Degradation (REDD) mechanism as mentioned during the Climate Summit of Copenhagen in 2009 (UNFCCC 2009).

4. Community participation and environmental education through the Niimi Biosphere Reserve

Through the process of establishing the Niimi Biosphere Reserve, a series of workshops have been organized with the aim of involving all concerned stakeholders. In 2002 a Technical Advisory Committee (TAC) has been set up in preparation of the more detailed biosphere reserve process that started in 2005. The TAC has responsibilities for advisory services, coordinating of development activities and the implementation of development programmes. The implementation instrument of the TAC at local ward level is the Multi-disciplinary Facilitation Team (MDFT). Within the framework of the NBR, the MDFT should facilitate the efficient and smooth participation of all stakeholders at a local level and promote ownership and sustainability. Unfortunately the MDFT, similar to the TAC, is facing problems of mobility of its members, of availability of financial resources and quality human resources. These difficulties hinder the smooth operation of these committees. Despite several attempts to provide solutions, the difficulties linked to financial resources still remain.

In December 2010 the NBR facilitated an exchange visit by a team comprising various community representatives, women counsellors and stakeholders from government institutions to the Saloum Biosphere Reserve in Senegal (Figures 6 and 7). The aim was to learn from experiences of the Saloum Biosphere Reserve with regards to sustainable livelihood practices. Some of these activities such as bee-keeping and vegetable gardens were identified by the team as pilot activities in The Gambia.



Figures 6 and 7: Exchange visit to Delta-du Saloum Biosphere Reserve, Senegal by local people and working group members

The NBR process has already resulted in better environmental awareness opportunities throughout the area. Examples of projects include:

- Social and environmental studies have been incorporated as a core subject at secondary school level and include text books and teachers' guides.
- The UNESCO Associated Schools Project Network has facilitated school-based Environmental Clubs country wide. Some schools are located in the Lower and Upper Niimi Districts within the NBR.
- Radio programmes on forestry issues such as bushfires are occasionally conducted by the Department of Forestry and the Environment. A national bushfire day is being coordinated annually on 10 December.
- The Niimi-Saloum Transboundary Project funded by Wings Over Wetlands (WOW).
- The Stay Green Foundation (SGF) is an environmental NGO operating within the NBR with an environmental education and communications component. The SGF facilitates and conducts programmes within target schools and communities, covering various topics such as climate change, desertification, biodiversity, chemical safety, bushfires, pollution and erosion control.
- Other NGOs involved in wildlife and protected area management issues include Makasatu Wildlife Trust, International Wildlife Trust, Gambian Education Network for the Environment (GENE) and WABSA (West African Bird Study Association).
- The Department of Parks and Wildlife Management has a programme of work on protected areas through which they conduct village sensitization programmes.

5. Management strategies

Management strategies supporting the NBR include the formation of a national Man and the Biosphere (MAB) Committee at ministerial level to handle national and international policies and politics. A working group was formed at the national level involving all stakeholders such as government institutions, NGOs, and local government

authorities directly operating within the biosphere reserve. This committee meets regularly to plan and implement activities designed in collaboration with local people. The group conducted situation analysis on all sectors with the support of international consultants, of which the information would be used to develop a management plan and complete the UNESCO nomination form. The activities include awareness raising through radio programmes, school presentations, community meetings, and environmental education programmes.

Community policing was one of the strategies promoted by a project titled "Convention on Biological Diversity (CBD) Programme of Work on Protected Areas". This project greatly assisted with protection because communities took ownership through their local systems, backed by the local government, and arrested and prosecuted anyone found doing illegal activities within their area of jurisdiction.

A draft management plan for the proposed biosphere reserve has been completed which is on the verge of validation (NBR 2010). It clearly explains all the necessary actions and stakeholders required to implement the biosphere reserve process, many of which are functional but need to be well coordinated in order to strengthen collaboration.

The coordination of the Niimi Biosphere Reserve will be the responsibility of the Ministry of Forestry and Environment (MoFEN), a Management Board (MB), Technical and Scientific Committee (TSC), and Local Management Team (LMT). Implementation of the biosphere reserve will be done collaboratively by a Multi-disciplinary Facilitation Team (MDFT), a Village Development Committee (VDC), NGOs, Community-based Organisations (CBOs), local populations, and research institutions. The coordination office will be located within the biosphere reserve.

During the entire biosphere reserve process, series of consultations were held with local communities where consensus was reached and also validation of the process was done at the national and regional levels. During the biosphere reserve mapping process, local communities have been consulted to minimize conflict over land. This was made possible because of sensitization, such as the exchange visit to the Saloum Biosphere Reserve of which some of the community members were part and had the opportunity to learn lessons from an existing biosphere reserve.

The biosphere reserve process is being funded by the IUCN office in Dakar, but the long-term funding after the completion is expected to come from donors and the government. Meanwhile, plans are on the way to secure funding for the future operation of the biosphere reserve.

6. Conclusion

Activities undertaken during the last phase of the NBR (2008–2011) have allowed achievements across eleven sectoral situation analysis and institutional analysis. Meaningful consultations were held with various stakeholders at all levels including the Governor's Office, Chiefdoms, village leaders, area councillors, parliamentarians, youth leaders, government agencies and the public at large. Institutional workshops and meetings allowed the NBR process to establish a dynamic working group representing

national and international NGOs, government structures, the Gambian University and other relevant projects. A strategy of collaboration and communication within the group was established.

The management of the Niumi Biosphere Reserve will tackle many problems such as green wood cutting, bush fires, salinization, coastal erosion, destructive fishing methods and fishing gears, invading plants, land tenure, overgrazing and above all poverty. The biosphere reserve approach has great potential to help in solving simultaneously most of these problems identified at different levels, while promoting sustainable development.

The creation and the management of the Niumi Biosphere Reserve initiative will boost sustainable development in The Gambia in an effective and efficient way, and in conformity with the willingness, needs and possibilities of the Gambian people and their government. The process of registration is expected to be completed during 2012.

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Príncipe Island's Biosphere Reserve (Democratic Republic of São Tomé & Príncipe): A Living Laboratory for Sustainable Development

La Réserve de Biosphère de L'île de Príncipe (République Démocratique de São Tomé & Príncipe): Un Laboratoire Vivant pour le Développement Durable

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Abstract

The island of Príncipe is an autonomous region of the Democratic Republic of São Tomé and Príncipe that submitted its application to UNESCO in September 2011 and was formally designated as a Biosphere Reserve in July 2012. A brief description of the main characteristics of Príncipe Island is provided together with the zonation scheme for the Biosphere Reserve. Due to its size and demography, Príncipe Island, can play a decisive role as a living laboratory demonstrating initiatives of nature conservation and sustainable use of natural resources for the well-being of its population. The local population will play an active role in the development of the Biosphere Reserve, considering that the Biosphere Reserve and the Regional Strategy for the Sustainable Development share all objectives and aims.

The designation of Príncipe as a Biosphere Reserve will also bring the integration of a new active country under the MAB programme and the AfriMAB network as well as in other thematic MAB networks (such as REDBIOS).

Key words: Biosphere Reserve; UNESCO; Príncipe Island; São Tomé; AfriMAB; REDBIOS

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Résumé

L'île de Príncipe est une région autonome de la République démocratique de São Tomé e Príncipe, ayant soumis une candidature à l'UNESCO en septembre 2011 et été officiellement classée comme réserve de biosphère en juillet 2012. Une brève description des caractéristiques principales de l'île de Príncipe est fournie ainsi que le programme de délimitation de la réserve de biosphère. De par sa taille et sa démographie, l'île de Príncipe peut jouer un rôle décisif en tant que laboratoire vivant, faisant la démonstration des initiatives de la conservation de la nature et de l'utilisation durable des ressources naturelles pour le bien-être de sa population. La population locale jouera un rôle actif dans le développement de la réserve de biosphère, considérant que celle-ci et la stratégie régionale pour le développement durable partagent tous les objectifs et buts.

La désignation de Príncipe en tant que réserve de biosphère donnera lieu également à l'intégration d'un nouveau pays actif aux termes du programme MAB et du réseau AfriMAB ainsi que d'autres réseaux thématiques du MAB (comme REDBIOS).

Mots-clés: Réserve de biosphère; UNESCO; Ile de Príncipe; São Tomé; AfriMAB; REDBIOS

1. Introduction

The island of Príncipe, with a terrestrial area of 142 km² and a maximum altitude of 948 m, is the smaller of the two islands that make up the archipelago and country of the Democratic Republic of São Tomé and Príncipe (Figure 1). Príncipe Island is an autonomous region, politically and administratively, with a local government and parliament, which, during the last years, are devoting much attention to the implementation of a sustainable development strategy for the island. This strategy is structured under the main constraints and opportunities that shape the island's socio-economic and environmental features.

Basically, accessibility/transport, tourism and agriculture, education/professional training, and nature conservation and biodiversity are, and will be, the main drivers of the near and long-term future of Príncipe Island. Together with a human history, including a high diversity

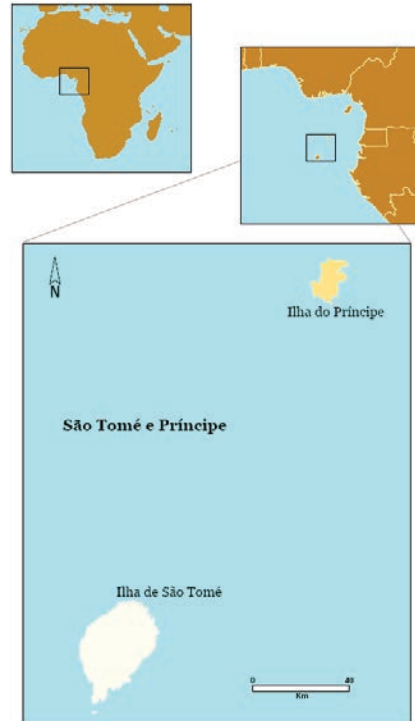


Figure 1: Location of Príncipe Island

of unique cultural features (music, language, human landscape, architecture and patrimony) these aspects will be used to build a wonderful story of sustainability, to be told and shared. In 2009, the Regional Government of Príncipe Island Autonomous Region has decided to start the process towards the application of the island as a future Biosphere Reserve, under UNESCO's Man and Biosphere Programme (MAB). This decision was supported by the national authorities as well as the Portuguese Cooperation, with the latter assuring the financial means to provide technical assistance. For nearly two years a team including Portuguese experts, together with a local government team in close collaboration with the national authorities and some key actors from other already existing UNESCO Biosphere Reserves, has cooperated, leading to the formal submission of the application in September 2011. During the application process, Príncipe Island has revisited its own sustainable development strategy, which coincides mostly with the principles and goals of the Biosphere Reserve. The reduced size of the island as well as its small population (7 542 inhabitants) makes Príncipe Island a suitable natural and social laboratory, willing to promote international cooperation. Príncipe Island Biosphere Reserve wants to act as a living laboratory of integration of conservation of the natural resources and biodiversity and its sustainable use in support of human well-being. Príncipe Island was designated as a Biosphere Reserve in July 2012 and is a new addition to the MAB Programme and the World Network of Biosphere Reserves, and also a new member of AfriMAB, REDBIO and the recently established World Network of Island and Coastal Biosphere Reserves.

2. Conservation, development and logistical support in Príncipe Island

The Biosphere Reserve of the Island of Príncipe is located in, and fully corresponds to the Autonomous Region of Príncipe, with its capital city in Santo António, covering a total area of 142 km².

Complementary to the terrestrial component, consisting of the entire island of Príncipe and the surrounding islets of Portinho and Boné de Jóquei and the Tinhosas, it also includes an extensive marine area. The Biosphere Reserve of Príncipe Island hosts a vast biodiversity and geodiversity. In addition to the natural values, Príncipe Island also shows a high diversity of unique landscapes, combining environmental and cultural features of great importance locally, nationally and internationally.

The lush vegetation of the Island of Príncipe, typical of tropical areas, includes an enormous biological diversity with a high number of endemic species of some of the Afrotropical ecosystems representative of the equatorial zone. The northern and central parts of Príncipe Island, consisting of plains and hills, have a relatively gentle topography. The southernmost area has a more abrupt terrain, with a small mountain range where the peak of Príncipe, the highest point the island, is found (Figure 2). It rises to an elevation of 948 m. Bom Bom and Boné de Joquéi (Jockey Cap) are some of the several islets and rocks surrounding Príncipe Island. These islets have a great interest from an ornithological point of view (Figure 3).

Príncipe Island's Biosphere Reserve, a living laboratory for sustainable development



Figure 2: Dense vegetation of Príncipe islands with the central peaks viewed from the South West coast of the island



Figure 3: Colony of Brown Booby (*Sula leucogaster*) resting in Boné de Joquéi Islet



Figure 4: *Príncipe Malachite Kingfisher (Alcedo nais)*



Figure 5: “Roça” Sundy

Príncipe Island's Biosphere Reserve, a living laboratory for sustainable development

The southwest coastal zones have a high level of protection (Natural Park of Príncipe Island) due to the extraordinary values of the existing primary and secondary forests, landscapes and geological features. The marine section on the south of the island also has conservation status and forms part of the Príncipe Natural Park. These areas correspond to the main core zone of the Biosphere Reserve.

The island of Príncipe is included in the biodiversity hotspot of tropical forests of West Africa. The terrestrial component of the Biosphere Reserve therefore includes a wide range of plant communities and habitats of high international importance such as primary tropical forests, shadow forests, palm trees and lowland riparian habitats. As an oceanic island, the native biological richness of Príncipe is accentuated by its geographic isolation, including several taxa of endemic flora and fauna (Figure 4).

Despite the relatively prolonged occupation and use of the territory, the landscape is only somewhat humanized. Land use consists mainly of forests and palm groves in the southern part, or mixed forests and palm groves with different cultures in the north, especially around the city of Santo António and in smaller “urban” centers such as Terreiro Velho, Porto Real, Sundy (Figure 5), Ponta do Sol and the surrounding areas of the airport.

The forest of Príncipe Island is part of the dense tropical humid forests of Africa, home to a high biological diversity. The global conservation importance is so high that the forest of Príncipe, together with those of the islands of São Tomé and Annobon, was considered as Africa's second most important forests in terms of conservation. It is thus classified by the World Wide Fund for Nature (WWF) as one of the 200 most important ecoregions in terms of biodiversity — part of the Tropical and Subtropical Moist Broadleaf Forests (Olson & Dinerstein 2002).

Despite its small size, Príncipe Island also hosts a wide diversity of natural ecosystems such as primary forest, mangroves, coastal dunes, coconut trees, riparian vegetation, and lowland ecosystems of inland waters, both lentic and lotic. Of the 450 species of flora present on the island of Príncipe, 44 are endemic to the archipelago and of these, 24 taxa are endemic to the island.

The indigenous terrestrial fauna of Príncipe Island include seven mammal, 28 bird, 13 reptile and three amphibian species. The invertebrate fauna, although less studied, include 42 species of Lepidoptera, 32 species of terrestrial molluscs and eight Neuroptera species. Recent data collection and research by the California Academy of Sciences (CAS pers. comm. 2011) indicates the presence of a great variety of beetles including several endemic species, especially among the Carabidae and Cerambycidae, suggesting that the vast and rich biodiversity of the island still has many secrets to be discovered.

Due to its geographical location at the point of convergence between the subequatorial Benguela current and the Gulf of Guinea's warm current, the marine fauna of the island of Príncipe display an enormous wealth and diversity. Thus far, 355 fish species (including pelagic species), 11 species of cetaceans, 5 species of sea turtles, 28 species of marine molluscs and several species of other marine invertebrates such as corals, crustaceans and echinoderms have been recorded.



Figure 6: *The city of Santo António, capital of Príncipe Island*



Figure 7: *Drying fish in the fishing village of Praia Burra*

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The population of Príncipe had a positive trend during this century, showing sustained annual growth. In 2001 the total resident population was 5 966 inhabitants (INESTP 2006) and in the last census of 2012 the number of inhabitants was given as 7 542 (INESTP in Tela Non 2012). The increase is due to a growth in the number of live births and reduced infant mortality, as well as increased life expectancy.

Príncipe is essentially an island where fishing and agriculture dominate and are practised as subsistence activities, particularly for consumption and trade on the local market. A small tourism component, mainly composed of residential tourism in the capital of Santo António (Figure 6) and a small island resort in the area of Bom Bom, is well integrated into the landscape. Agriculture and fish products are mainly consumed in its primary form, but there are some processed products such as dried fish (Figure 7), fried bananas, the “cacharamba” (local sugar cane rum) and palm wine.

Considering the current model of socio-economic development of Príncipe, based on a multicultural origin with great concern for the sustainable use of natural resources and a unique identity of its people, the Biosphere Reserve will naturally enhance the sustainable livelihoods of the people. This will be achieved by restructuring and developing the main economic activities, and using the excellent weather conditions, as well as historical, cultural and landscape attributes in furthering the cause of the Biosphere Reserve. The outstanding efforts by the Regional Government of Príncipe in the planning and territorial management of natural resources, as well as in promoting sustainable development, are reflected in the implementation of several existing and ongoing acts and plans. These include the creation of the Natural Park of Príncipe in 2006 (Figure



Figure 8: View of the south-east part of the Natural Park of Príncipe

8), the Action Plan for the Natural Park, the Management Plan of the Natural Park of Príncipe, and specific legislation promoting best farming practices.

Aware of the importance of the level of preparation and human resource skills required for the proper management of their natural resources and cultural heritage, the government of the Autonomous Region of Príncipe (Figure 9), in collaboration with the government of the Republic of São Tomé and Príncipe, has organized several training courses for its staff, in particular through partnerships with NGOs and the European Union (ECOFAC). Several projects have also been implemented in distinct areas such as social, health, culture and education in partnership with the Portuguese Cooperation. In order to involve the local population and raise awareness of the importance of their involvement in the successful implementation of the plans, several information campaigns on environmental legislation were organized, resulting in the participative creation of the management plans and specific rules for the Natural Park of Príncipe.

Due to the tropical rainforest and low population figures, the island of Príncipe has many unique and valuable natural and landscape assets, with high potential use for nature tourism, ecotourism and other forms of sustainable tourism.

The existing non-governmental cultural and environmental organizations of Príncipe Island have several initiatives to preserve local traditions and the environment. They play a key role in engaging the community in enhancing the touristic value of the island by complementing the normal tourism products, based on biological diversity and geological features, with active cultural and ethnographic activities linked with nature. The creation of a Biosphere Reserve is seen as a tool for promoting and encouraging



Figure 9: The main square of city of Santo António with the Government and Parliament buildings

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activities based on the conservation and sustainable use of natural and cultural heritage. The Biosphere Reserve is expected to enhance opportunities for diversification of local development, and to help identify and promote initiatives to revitalize the economy and social development in Príncipe, with significant benefits for the local population.

In addition to the vast natural heritage, the Island of Príncipe owns a beautiful and rich cultural heritage that extends from the built heritage to the intangible heritage of dancing, costumes, music and their own language, or “lunguyê Príncipe”, only spoken on the Island of Príncipe. The built heritage includes the seventeenth-century Portuguese Fort of Santo António da Ponta da Mina, the church of Nossa Senhora da Conceição, the fountain of the Plaza Marcelo da Veiga (Figure 10), the Monument of the Discoveries in the port of Santo António, the pattern of St. António and the memorial to Camilo Domingos.

Other buildings of cultural interest provide harmony to the urban landscape. These include some buildings showcasing Portuguese colonial architecture, spaces reserved for local businesses like the old fish market in the central square Marcelo da Veiga, and several grocery stores which still retain their original characteristics. Another type of building of high historical and cultural interest is the “roças” (farms) which are scattered throughout the island (Figure 11). These ancient farms — authentic small towns of great beauty — are *par excellence* places with high potential for rural tourism, agrotourism



Figure 10: Fountain from the early twentieth century in the main square (Marcelo da Veiga) of Santo António



Figure 11: Roça Belmonte



Figure 12: Auto de Floripes played by students

Príncipe Island's Biosphere Reserve, a living laboratory for sustainable development

and cultural tourism, thus enhancing sustainability within the small communities that currently live there.

Combining the history of colonization and its geographic isolation, the island of Príncipe merged all its cultural influences into a unique local cultural heritage. This multicultural mix is evident in several popular events, including poetry, festivals, music, food, musical instruments and traditional medicine.

Cultural manifestations typical of the island of Príncipe include religious events like the "Vindes menino" on December 31 to celebrate the birth of Christ, the feast of Nossa Senhora da Graça, and the feasts dedicated to popular saints such as the feasts of Santo António, São João, Santa Cruz Nascido, Nossa Senhora do Socorro and the São Lourenço or Auto de Floripes (Figure 12). The latter is the most important festival of the Island of Príncipe. It is a feast of Portuguese origin, celebrating a legendary tale among Christians and Moors. Participation is very popular and it takes place in the streets of Santo António.

On the island of Príncipe the "Deixa" or "Dexa" is a typical local dance, but there are several kinds of folk manifestations with influences from other areas of the African continent such as the "Puita" and "Dança-congo" of Angolan origin and the "Tchabeta" with Cape Verde influence. Although usually associated with celebrations of Nossa Senhora da Graça, the "Deixa" is sometimes used in other cultural and popular events.

As a result of the recent increase in scientific cooperation projects, there is a growing presence of an international scientific community on the island. It is expected that the Biosphere Reserve will be a living laboratory covering different experiences and initiatives dealing with socio-economic, cultural and natural dimensions. Any experiment and project will have a visible impact on the island due to its small size, but also due to the close proximity and involvement of people.

In the natural sciences, and particularly in nature conservation and biodiversity, Príncipe Island is already prominent in several fields. One of them is the turtle conservation project covering not only scientific issues, but also social awareness on the conservation of the different turtle species. A field station was built to accommodate visitors for monitoring and turtle watching in Praia Grande, one of the main nesting areas of sea turtles on the island (Figure 13). This logistical support has proved to be fundamental to the success of the project, including spreading of activities throughout the local population. The headquarters of the Natural Park of Príncipe also serve as a training and environmental education center (Figure 14) and is expected to create a didactic and pedagogic facility to support schools, students and future research and conservation of local biodiversity projects.

Also notable is the growing dynamic of local people's participation, both through government and non-governmental organizations, in activities related to the development and preservation of culture and traditions of the island. In this context, some actions are planned such as the creation of organizations specifically oriented to support culture and young poets, an ethnographic museum and an audio library covering different vocal registers, from the local languages and dialects, the songs, stories and legends, to the reported histories from the older population.



Figure 13: Monitoring sea turtle nesting at Praia Grande



Figure 14: Príncipe's Natural Park headquarters



Figure 15: *The Cultural Center of Santo António, Príncipe Island*

With respect to the geological heritage, local authorities wish to classify some interesting geological formations as geological monuments, especially the altitude formations located in the southern mountainous part of the island inside the Natural Park of Príncipe.

An important logistical infrastructure for research projects in the fields of anthropology, literature, ethnography and archaeology, is the Cultural Center of Príncipe in the city of Santo António (Figure 15). This Cultural Center houses a vast collection of records and has facilities that provide excellent support to researchers.

The logistical support to various projects foreseen in the Biosphere Reserve proves the dedication of local authorities to sustainable development. Designation of Príncipe Island as a Biosphere Reserve will surely provide an opportunity to promote interdisciplinary interventions, broadening the scope of research, education and information at an international level.

3. The establishment of the Biosphere Reserve of Príncipe Island

The Regional Government of Príncipe, in partnership with public and private entities, developed national and international activities related to research, monitoring and safeguard of the natural heritage, as well as other initiatives dedicated to environmental education, and cultural and spiritual heritage.

The information gathered with these actions was published and is available for consultation, providing support for future research and monitoring in the Biosphere Reserve which is now an effective member of the Network of Biosphere Reserves of the

Eastern Atlantic (REDBIOS), the Network of Biosphere Reserves of Africa (AfriMAB) and the recently established World Network of Island and Coastal Biosphere Reserves. The process leading to the application of Príncipe Island as a UNESCO Biosphere Reserve was much more than a technical and scientific initiative as it had significant participation by the public. Public sessions and a consultation process were developed and massive support from the inhabitants was achieved. There is an effective purpose to use the Biosphere Reserve as a central tool for the implementation of the Island's sustainable development strategy.

The island of Príncipe is one of three existing oceanic volcanic islands of the Gulf of Guinea and, at 31 million years old, is geologically the oldest of this group. The island is characterized by its soft relief in the northern half of the island and, in the southern part for its mountain range, composed of several phonolitic peaks with altitudes between 500 and 948 m, where the main patch of the primary rainforest is located. The differences in geomorphology and topography between these two parts of the island result in a differentiated bioclimatology, thus influencing the distribution of major types of ecosystems of the island, such as the lotic systems in the area of the massif and its valleys and the lentic systems in the northern plains.

The Biosphere Reserve includes the entire surface area of the island of Príncipe and its islets Bom Bom, Boné do Jóquei, Mosteiros, Santana and Pedra da Galé, as well as the islands Tinhosas, located about 20 km south-southwest of the island of Príncipe. It also includes an extensive marine area down to 50 m deep around Príncipe and Tinhosas (Figure 16).

The Biosphere Reserve hosts a high biodiversity in terrestrial as well as in marine ecosystems, with high rates of endemism in many groups of organisms, especially vascular plants, molluscs, insects, birds, reptiles and bats. Considering the importance that this area has for the reproduction of sea turtles, seabirds and cetaceans, as well as coral reefs, it is an area of great conservation relevance for global biodiversity.

Considering that the Gulf of Guinea includes only three tropical oceanic volcanic islands with unique natural and cultural features, the establishment of the island of Príncipe as a Biosphere Reserve makes it the first of its kind in the World Network of Biosphere Reserves, undoubtedly enriching the thematic (e.g. REDBIOS) and geographic (AfriMAB) networks with whom Príncipe is already cooperating.

The main economic activities in Príncipe are agriculture (especially cocoa, coffee and copra), fishing and tourism. The resident population in the Biosphere Reserve is 7 542 inhabitants, all living in the transition zone. All the islets around Príncipe are uninhabited.

The core areas of the Biosphere Reserve are integrated with the Natural Park of Príncipe and include the Tinhosas islands, classified as reserves and wetlands of international importance under the RAMSAR Convention. Buffer zones include areas within the Natural Park of Príncipe classified as partial reserve and regulated by several existing instruments of management of natural resources and land planning. The transition areas include public and private urban areas, and regulated urban-rural and rural areas.



Figure 16: Zonation of the Biosphere Reserve of Príncipe Island

The major ecosystems represented are the oceanic island with equatorial tropical habitats typical of the flat forests of the ecoregion of the Gulf of Guinea islands. Other ecological units correspond to the native vegetation of the tropical rainforest, lentic riparian habitats and lotic tropical, mangrove, coastal habitats including vegetated islets, coral reefs and oceanic islets.

The executive support for the management policy of the Biosphere Reserve will be based on lines of action defined in the various plans and programmes designed and enacted by the legislation as guidelines for the socio-economic development of the Biosphere Reserve. These include in particular the Strategy Development Plan of Príncipe Island, the Management Plan of the Natural Park of Príncipe, the Handling Plan for the Natural Park of Príncipe, the Fisheries Act, the Forest Law, the Basic Law of the Environment and the Law of Conservation of Fauna, Flora and Protected Areas. These will be complemented by a specific management plan for the Biosphere Reserve. This management plan will aim to boost sectoral plans and will promote the integration of the local community in the sustainable development of the Autonomous Region of Príncipe, in accordance with the guidelines set for the Biosphere Reserve.

Initially serving as a catalyst for the different institutional contributions, both public and private, around the Biosphere Reserve, the Government of Príncipe will assume the role of executive manager, and as the designated authority for implementation of the various planning mechanisms. There will be a permanent Advisory Council for the Biosphere Reserve which will include the different public and private stakeholders. A Scientific Committee will also be established, involving local, national and international individuals and institutions.

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Securing Farmers' Livelihoods around the Bia Biosphere Reserve through the Use of a Low-Cost Anti-Elephant Raid Technique

Protéger les Moyens de Subsistance des Agriculteurs aux Alentours de la Réserve de Biosphère par L'utilisation d'une Méthode Économique de Lutte Contre les Attaques D'éléphants

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Abstract

The raiding and damage of crops by wildlife, especially cocoa by elephants, inflict serious economic losses and hardship on the farmers of Bia Conservation Area (BCA) in Ghana, leading to loss of livelihoods and food security. The victims are not able to meet their obligations to their families, the District Assembly and the community. The country loses foreign exchange in the case of cocoa. This creates frustration and conflict with the BCA authorities. The farmers feel it is the responsibility of Wildlife Division (WD) to control 'their' animals. The traditional elephant deterrent methods have not been effective besides being very labour intensive.

To deal with this situation, the *Foundation for Sustainable Management of Natural Resources* (FSMNR) with support from the EU and collaboration with the WD, introduced a low-cost anti-elephant crop raid intervention based on the use of dried powdered chillies by some selected farmers around the northern part of BCA. This intervention has been successfully used in the Kakum Conservation Area over the past five years. The principle underlying this intervention is that the noxious smell of powdered chillies irritates the nasal passages of elephants, which thus avoid the farms.

A workshop was organised at Kukumso in the Bia District for 25 selected farmers from five communities and some other stakeholders to train the farmers in the use of the technique. These farmers would serve as volunteers who would help other

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farmers to replicate the method and also ward off elephants in the event of an attack by elephants. As an incentive, the volunteers were resourced to carry out their functions.

As the method is a novelty, the farmers agreed that the intervention should be carried out on one selected farm in each of the five communities for proper assessment over a period of at least six months during which the left-over materials would be used to consolidate the intervention. The method was intensively discussed in the field and a demonstration was set up. The farms were closely monitored and early results indicate no crop damage in spite of signs of elephants in the vicinity of the farms.

The workshop was seen to have been extremely worthwhile by the farmers and a key output of setting up of demonstration farms was realised.

Key words: BCA, crop damage, elephants, livelihoods, food security, low-cost, powdered chillies

Resume

Les attaques et les dégâts sur les récoltes causées par les animaux sauvages, notamment sur les plantations de cacao par les éléphants, infligent de graves pertes économiques et engendrent des difficultés pour les agriculteurs de la zone de conservation de Bia (BCA) au Ghana, donnant lieu à la perte de moyens de subsistance et de la sécurité alimentaire. Les victimes ne sont plus en mesure de rencontrer leurs obligations vis-à-vis de leurs familles, du Conseil régional et de la communauté. Le pays perd des devises en ce qui concerne le cacao. Ce problème crée des frustrations et des conflits avec les autorités de la BCA. Les agriculteurs estiment qu'il est de la responsabilité de la Division de la faune (WD) de contrôler 'ses' animaux. Les moyens de dissuasion traditionnels pour lutter contre les attaques d'éléphants n'ont pas été efficaces en dehors du fait qu'ils nécessitent une main d'œuvre intensive.

Pour remédier à cette situation, la *Fondation pour la gestion durable des ressources naturelles* (FSMNR) avec le soutien de l'UE et en collaboration avec la WD ont lancé une intervention peu coûteuse de lutte contre l'invasion des éléphants basée sur l'utilisation de piments secs en poudre par quelques agriculteurs choisis autour de la partie nord de la BCA. Cette méthode a été utilisée avec succès dans la zone de conservation de Kakum au cours des cinq dernières années. Le principe à la base de cette intervention est que l'odeur nocive des piments en poudre irrite les voies nasales des éléphants qui de ce fait, évitent les exploitations agricoles.

Un atelier a été organisé à Kukumso dans la province de Bia pour une sélection de 25 agriculteurs de cinq communautés et certains autres intervenants, en vue de former les agriculteurs à l'utilisation de cette méthode. Ces agriculteurs ont servi de volontaires qui aideront leurs collègues à reproduire la méthode et à chasser les éléphants en cas d'attaque. A titre d'incitant, les volontaires ont bénéficié des ressources leur permettant d'exercer leurs fonctions.

Etant donné le caractère novateur de cette méthode, les agriculteurs ont accepté que l'intervention se déroule sur l'une des exploitations agricoles sélectionnées dans chacune des cinq communautés afin d'effectuer une évaluation correcte pendant une durée d'au moins six mois, au cours de laquelle les matériaux restants seront utilisés pour consolider l'intervention. La méthode a fait l'objet d'une discussion intense sur le terrain et une démonstration a été mise en place. Les exploitations ont été surveillées de près et les premiers résultats n'ont indiqué aucun dégât sur les récoltes malgré les signes de présence d'éléphants aux alentours.

L'atelier s'est révélé extrêmement intéressant pour les agriculteurs et l'une des conclusions qui en a découlé a été l'implantation d'exploitations agricoles de démonstration.

Mots-clés: BCA, dégâts des récoltes, éléphants, moyens de subsistance, sécurité alimentaire, économique, piments en poudre

I. Introduction

I.1 Background

Bia Conservation Area (BCA — also known as the Bia Biosphere Reserve) is a high forest Protected Area (PA) located in the Juabeso and Bia Districts in the Western Region of Ghana (Figure 1). It comprises Bia National Park and the Bia Resource Reserve. It lies between latitude 6° 20' and 6° 38' and longitude 2° 58' E and 3° 58' W (Figure 2).

The PA received massive investment support from the European Commission's sponsored Protected Area Development Programme Phase II (PADP II). The purpose of the intervention was to consolidate and extend long term management prospects for this PA and to empower civil society to manage and benefit from natural resources in a sustainable manner. The overall objective was to reduce poverty through enhanced conservation of biodiversity.

A key result area of PADP II was to improve effectiveness of law enforcement and to monitor poaching. A significant achievement under PADP II is the increase in frequency of mammal sightings as evidence of a growing population of some wildlife species. Available data also confirm reduction in illegal activities such as poaching. Relations between Wildlife Division of the Forestry Commission (WD) and the communities have greatly improved using the Community Resources Management Area (CREMA) and Protected Area Management Board (PAMAB) concepts (Wildlife Division 2000).

BCA has a total area of 306 km² and is an important stronghold of endangered mammals including African forest elephants and chimpanzees. There appears to be an increasing elephant density within BCA over the last 25 years.

In a recent assessment in 2009, BCA was estimated to support 133–138 elephants, accounting for almost a third of forest elephants in Ghana. There are 43 major communities within a 5 km radius of BCA who are mainly cocoa farmers (Table 1). Table 2 shows the communities that experience elephant crop raiding.



Figure 1: Location of Bia Conservation Area in Ghana

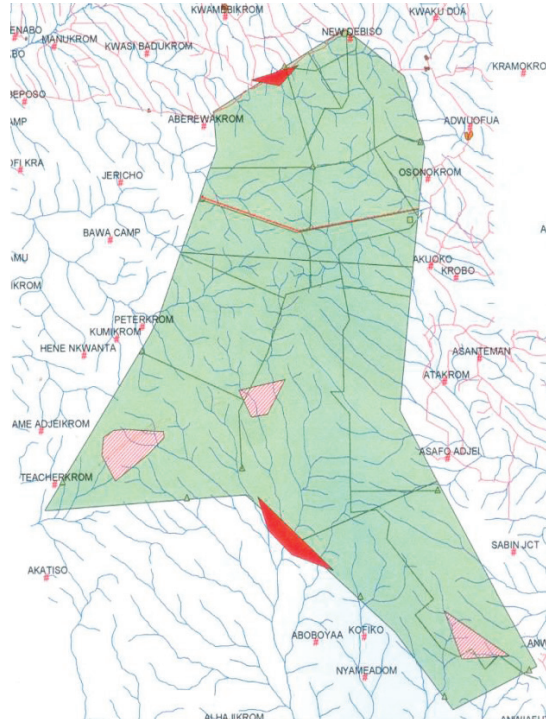


Figure 2: Map of Bia Conservation Area

Table 1: Major Communities around Bia Conservation Area

1	Kwamebikrom	2	Abrewakrom
3	New Wenchi	4	Nyamedea
5	Benkasa	6	Abosi
7	Hene Nkwanta	8	Kofie Abesimu
9	Kofie Ponko	10	Teacherkrom
11	Akatiso	12	Nafana
13	Kwabena Kra Krom	14	Aboboyaa
15	Kofiko	16	Nyamebekyere
17	Bonsu Nkwanta	18	Manso Krom
19	Aweafutu	20	Safo Nkwanta
21	Asafo Adjei	22	Ntosue
23	Attakrom	24	Boateng krom
25	Annokrom	26	Asanteman
27	Obeykrom	28	Akuokokrom
29	Osonokrom	30	Adjofua

31	Kwame Tawiakrom	32	Asuopri
33	Beposo	34	Boinzan
35	Mafia	36	Debiso
37	Asuontaa	38	Mepeasem
39	New Agogo	40	Atemuda
41	Eberekrom	42	Sakyikrom
43	Kukumso		

Table 2: *Communities Affected By Elephant Crop Raiding*

1	Bia village	2	Ahweafutu
3	Boafoyena	4	Gyau camp
5	Biokrom	6	Ameneye-Agya
7	Yebediagro	8	Camp5 Village
9	Koneagya	10	Baah Akura
11	Yiadomkrom	12	Nyamebkyere
13	Boamponkrom	14	Akosua Addaekrom
15	Kwasi Donkor Camp	16	Eyenyamekrom
17	Kojo Donkor Camp	18	Asiri
19	Alhaji Nkwanta	20	Gyabi Taisider
21	Atta Game Village	22	Debebi
23	Teacherokrom	24	Abrewakrom
25	Sukusuku	26	Kwame Tawiakrom
27	New Wenchi	28	Kukumso
29	Agya Manu Akura	30	Iron Boy
31	Camp 10	32	Safo Nkwanta
33	Adjoafua		

1.2 Justification

BCA is under constant pressure as surrounding forests are being cleared for cocoa plantations and other crops such as plantain, cassava, maize and vegetable farms. This results in a dramatic reduction in elephant range and increases elephant density and conflict situations with farmers. This situation is the same elsewhere in Ghana (Barnes *et al.* 1995, Boafo *et al.* 2004).

Farmers who suffer crop raiding could lose their entire crops resulting in significant losses to the farmers as indicated in Table 3. It is on record that some farmers, out of frustration, illegally recruit the services of hunters to control the elephants.

Table 3: Crop Raiding Statistics BCA*

Year	No. of Farmers	Total no. of elephants	No. of elephants crop raiding	Crops affected	Farm size (ha)	Portion damaged (ha)
2009 [†]	5	138	36	Cocoa, plantain, banana, yam, maize, okra, cocoyam	4.23	0.45
2008	18		92	Cocoa, plantain, banana, yam, maize, okra, cocoyam	38.4	9.38
2007	5	133	44	Cocoa, plantain, banana, yam, maize, okra, cocoyam	15.78	2.63
2006	17		201	Cocoa, plantain, banana, yam, maize, okra, cocoyam	44.31	6.88

* Source: BCA data 2009

[†] Jan–Oct

Elephant crop raiding, especially of cocoa (Figure 3, 4 and 5), has therefore become a source of conflict between WD, the communities and the political authorities (Barnes 2002). Crop raiding also results in loss of valuable foreign exchange for Ghana. It is therefore imperative to put in interventions either to mitigate the effect of crop raiding or prevent it altogether if the gains made under PADP I and PADP II are to be sustained.



Figure 3:
Mature cocoa pods



Figure 4:
Damaged cocoa pods



Figure 5:
Madam Gladys, a farmer, with damaged cocoa pods

To mitigate the crop raiding menace, it was therefore proposed to build capacity of the farmers and the community members to handle the situation through the introduction of a low cost technology using a paste of powdered chillies and used engine oil.

It is of interest to note that this technology has been successfully used at the Kakum Conservation Area in the Central Region since 2007, with financial support from the UN Food and Agriculture Organisation (FAO), the World Bank under the High Forest Biodiversity Conservation Project and the International Fund for Animal Welfare (IFAW) (FAO 2003, FAO 2008, FAW 2008, FC 2006, Kruse 2004). The project was implemented by the Wildlife Division of the Forestry Commission in collaboration with the Extension Services Division of the Ministry of Food and Agriculture (MOFA).

1.3 Objective

The objective of the intervention was to introduce a simple low-tech and affordable anti-elephant crop raiding intervention that will lead to a reduction in the incidence of crop raiding in BCA and thereby securing the livelihood of the farmers.

1.4 Outputs

- Farmers equipped with knowledge to use the new technology.
- Demonstration farms set up to demonstrate the efficacy of the technology.

2. Methods

2.1 Determination of communities and farmers for the intervention

Following discussions between the Management of BCA and the *Foundation for the Sustainable Management of Natural Resources* (FSMNR), five communities were selected for the intervention. The communities are located in the northern sector of BCA and were identified from Park records as the worst affected by elephant crop raiding. The communities were Adjoafua, Kukumso, New Wenchi, Kwame Tawiakrom and Abrewakrom (Table 2).

Discussions were held with each of the selected communities which then selected five individuals to attend the workshop. The understanding was also reached that those individuals would serve as volunteers who would teach other farmers how to use the new technology. Additionally they would also function as guards who would support other farmers to drive away elephants, should these visit the farms.

The communities were therefore represented by 25 individuals of whom two were females.

2.2 Workshop

In collaboration with the Management of BCA, FSMNR organised a workshop on 24 August 2010 at the Church of Pentecost premises, Kukumso in the Bia District (Figure 6). The purpose of the workshop was to introduce participants to the new low cost anti-elephant crop raiding technology based on the use of a paste of chillies and used engine

oil (Kruse 2004). The workshop was also attended by the representatives of MOFA, Bia District Assembly and Vision FM (a local radio station).

2.3 *Expectations of participants at the workshop*

2.3.1 Communities

1. To know the materials to be used to prevent the elephants from entering our farms.
2. The new method would contain elephants within their range.
3. Our farms would be free of elephant raids and we will have our peace.
4. To know the support that we can receive from Wildlife Division to deal with crop raiding.

2.3.2 Agricultural Extension, Ministry of Food and Agriculture

1. The new intervention would not be expensive so that farmers will be able to bear the cost.

2.3.3 Wildlife Division

1. The success of the new intervention would help reduce conflicts with the communities.
2. Enhanced collaboration with the communities.
3. Farmers would adopt the new method.
4. Farmers would know how to channel their grievances regarding elephant crop raiding.

2.4 *Traditional methods to control crop raiding*

The workshop reviewed and evaluated the traditional methods being used by the farmers to control the damage (also FAO 2003, Osborn & Parker 2002). The methods discussed were:

- Noise (banging on empty metal drums, use of bells, bamboo blasters (the sound of which is similar to gunshots), shooting in the air.
- Fire (burning of palm kernels or tyres).
- Burning of elephant dung mixed with pepper.
- Guarding of farms day and night.
- Reporting to WD to repel or kill the marauding elephants.

It was emphasized that the new technology was not meant to replace the traditional methods but rather to complement them. After comprehensive deliberations, participants were introduced to the chilli technology of which they have already heard.

The materials required for the new method are:

- Wooden poles for fencing.
- Nylon ropes for hanging rags or small bells.
- Rags to carry mixture of oil and pepper powder.
- Used engine oil/grease as adhesive for pepper powder.
- Powdered chillies as the repellent.

2.5 The new method to control crop raiding

It was explained that grease has better adhesive qualities but is expensive. It was also re-emphasised that the 25 community individuals would serve as trainers for other farmers in the use of the technology since the materials would not be enough to cover all the affected farms.

In this regard, each of them received a raincoat; overall, pair of Wellington boots, machete, torchlight and set of dry cell batteries as incentive to perform, particularly in the event of elephant raids on farms (Figure 7).



Figure 6: Mr. Alex Akwoviah (right) of FSMNR stressing a point at the workshop



Figure 7: Volunteers in their uniforms

2.6 The demonstration farms

The communities decided among themselves to select five individual farms from each of the communities that were experiencing severe crop damage to set up demonstrations as pilot sites (Table 4).

Table 4: Farms selected for demonstration

Name of farmer	Community	Crops grown	Farm size (ha)
Michael Donkor	Kukumso	Cocoa	1.21
Nana Ansu Gyeaboa	New Wenchi	Cocoa	1.82
Kwasi Nkrumah	Adjoafua	Cocoa	1.42
Kwaku Addae	Kwame Tawiakrom	Cocoa	1.21
Gladys Akopo (a.k.a Auntie Yaa)	Abrewakrom	Cocoa	2.43

2.7 Preparation and deployment of materials

The dried powdered pepper (*Capsicum annuum*) and engine oil were mixed into a paste in the ratio of 3:1, the engine oil serving as adhesive for the chillies (Figure 8). The mixture was then applied to the rags.

A number of poles depending on size of farms were stuck along the farm boundary at intervals of 3 metres and the nylon rope not less than 0.4 cm in diameter was tied from one pole to the other around the whole farm or along a boundary. Some cocoa trees along the boundary were also used as anchors for the ropes. The rags with the impregnated chillies were then tied to the rope at intervals of 2 m (Figure 9).



Figure 8: *Preparing the ingredients on the farm*



Figure 9: *Chilli rags hanging on ropes along farm periphery*

It was explained that as the wind blows over the rags it carries the noxious smell of the pepper around the farm vicinity to irritate the nasal passages of any elephant that comes into contact with it through the air and thus repelling the animal.

On 26th August 2010, one demonstration was set up on a farm at New Wenchi, followed by another two at Abrewakrom and Kukumso the following day. The last two were set up at Kwame Tawiakrom and Adjofua on the third day.

The next four days were used to closely monitor the pilot sites since it was the season of very high crop raiding. Though signs of elephants were observed, no damage was detected. This initial result convinced the farmers about the effectiveness of the method.

3. Monitoring and evaluation

Field reports indicated that there was only one report of an attempted invasion by elephants. When this was investigated it was found that the incident occurred through a portion of the farm that did not have the fence. The left over items were also given to the farmers to reinforce the intervention. To fully evaluate the project, a team comprising FSMNR, Head of Community Unit and Agricultural Extension and field staff visited the project sites from 25 to 28 October 2010. The team met with the six volunteers and the Chairman of the Community Resource Management Committee. During discussions the volunteers led by the Chairman testified to effectiveness of the intervention against elephant raids so far. It was also noted that no farmer had so far adopted the intervention in spite of the success. They explained that they would do so as soon as they receive some money. Further discussion revealed that they expected the Government to supply the needed items. The volunteers were encouraged to view the intervention

as a normal farm practice if they were to protect their crops and make any profits. The Chairman called for more interaction between WD and the communities to reinforce and maintain interest in the intervention. The team also learnt that some farmers in the southern sector of BCA have adopted the method though they did not participate in the workshop.

During the visit to one of the demonstration farms it was found the pungent smell of the pepper was reducing and that the fence was incomplete. It was explained that, since the adoption of the intervention depended on the success of the demonstration farm, it was essential that the farmer followed all the best practices and maintain the intervention. The farmer was advised to reinforce the pepper and close the gaps in the fence and regularly maintain it.

The team visited Abrewakrom and interacted with Madam Gladys Akopo who had a demonstration farm. She and the others attested to the effectiveness of the intervention so far and explained that this had made it possible for them to concentrate on other farm operations. The discussion centred on sustainability of the intervention. Here too some of the farmers were expecting government to provide the items. As was the case at Kukumso, they were encouraged to procure their own items. It was also found that the pungent smell of the pepper was diminishing.

Discussion with other farmers in the area indicated that they were willing to adopt the new method, but they were waiting to see the full effectiveness of the intervention on the farm of Madam Gladys Akopo.

Though it was not possible to visit the other farms due to heavy rains, indications are that the intervention is working satisfactorily.

4. Conclusion

It is well established that for any human-wildlife conflict management strategy to succeed, it must be sustainable and therefore ideally administered by the local community itself.

The farmers demonstrated great enthusiasm and commitment to implement the new technology and therefore in this regard the workshop was seen to have been extremely worthwhile. The key outputs of farmers knowing the new method and setting up of demonstration farms were realised. However, the challenge is the periodic reinforcement of the pungent smell (potency) which calls for close monitoring and significant expenditure on pepper which is the most expensive material among the items. The need for checking the rags at short intervals and reinforcing at least every four weeks in view of the wet and rainy nature of the environment was emphasized.

The useful inputs and advice from the participants concerning different ways of making the intervention successful is quite significant. The indication during the workshop that the Bia District Administration would in principle be willing to buy pepper for the farmers, since the damage was of great concern to the Assembly in terms of revenue loss, is laudable.

Furthermore, it was very heartening to note that some farmers at Adjofua indicated that they would be willing to make individual contributions on a cooperative basis to purchase the dried pepper in bulk to sustain the effectiveness of the intervention.

5. Recommendations

As there are indications that the intervention on the pilot farms would be successful, the following recommendations are made:

1. There is an urgent need for a similar workshop to extend the technology to the southern sector where crop raiding is also experienced.
2. As the intervention was carried out on only five selected farms in the northern sector, there is a need to ensure that the success is replicated on the other farms within the sector.
3. To sustain the intervention and enthusiasm of farmers, regular monitoring of the farms by Community Relations Unit of Wildlife Division is highly recommended in addition to regular engagement with the farmers to address any issues.
4. Wildlife Division should follow up on the Bia Assembly's desire to support the farmers with the pepper and also encourage the Adjofua community to procure the chillies as they indicated at the workshop.
5. Protecting crops against elephants should be seen by all stakeholders as part of normal agricultural husbandry practices, in which case farmers should be prepared to incur some expense on the materials just as they would do on chemicals and fertilisers or other inputs. Wildlife Division is therefore encouraged to work closely with the Bia District Assembly, Juaboso Bia District Assembly and the farmers on a regular basis through meetings. This is the only way to persuade farmers that elephants are the property of Wildlife Division and should therefore be solely responsible for the damage caused.
6. Cocoa Board is a major stakeholder in the cocoa industry. Wildlife Division should therefore contact it to explore the possibility of getting it to endorse the new intervention and provide more resources to the farmers in order to sustain the intervention.

6. Acknowledgements

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Co-management of Small-scale Fisheries: the Case of the Mare aux Hippopotames Biosphere Reserve in Burkina Faso

Cogestion des pêcheries artisanales: cas de la Réserve de Biosphère de la Mare au Hippopotames au Burkina Faso

JEAN-ANDRE T. KABRE¹ • ALFRED MILLOGO¹ • ADDEY Y. YOUSOUF¹

Abstract

This study focuses on the ecology and biology of the resources in the biosphere reserve and the utilization of these resources by the riparian populations. More specifically, the work presents the state of halieutical resource production and utilization by the populations involved in the fisheries of the Mare aux Hippopotames Biosphere Reserve in Burkina Faso. Firstly, the authors describe the lake's biodiversity by listing its 34 species of fish as well as several macro-invertebrate families and genera found in the lake. Secondly, they examine a method of preserving fish using lemon juice; a method which reinforces traditional knowledge of post-capture fish preservation techniques. The production and utilization of species of great economic interest were evaluated by means of population dynamics parameters and fishing statistics.

Key words: biosphere, small-scale fisheries, biodiversity, preservation, Burkina Faso

Résumé

Cette étude s'intéresse à l'écologie, la biologie des ressources de la réserve de biosphère et de l'utilisation de ces ressources par les populations riveraines; plus spécifiquement le travail présente l'état de la production et de l'exploitation des ressources halieutiques par les populations impliquées dans la filière de production

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de la Biosphère de la Mare aux Hippopotames au Burkina Faso. Les auteurs, d'une part, donnent la biodiversité de la mare riche de 34 espèces de poissons et plusieurs familles et genres de macro-invertébrés. D'autre part ils décrivent une méthode de conservation du poisson par le jus de citron; méthode qui vient renforcer les connaissances traditionnelles en technique de conservation du poisson post capture. L'état de la production et de l'exploitation des espèces de grand intérêt économique a été évalué à travers des paramètres de la dynamique des populations et de statistiques des pêches.

Mots clés: biosphère, pêcheries artisanales, biodiversité, conservation, Burkina Faso.

1. Introduction

Burkina Faso is a land-locked country, which means that all its waters are inland fresh waters such as lakes, streams, natural rivers as well as artificial lakes and dams. The Mare aux Hippopotames Biosphere Reserve (*Réserve de Biosphère de la Mare aux Hippopotames*) is one of these natural lakes. All these stretches of water have become, to varying degrees, small-scale fisheries and sources of plant, aquatic animal and insect products benefitting the populations. The resources comprise 330 species including fish (121 species), amphibians (30), reptiles (20), birds (54), molluscs (28), crustaceans (7), insects (54), plankton (16), algae and plants (Ouédraogo 1998), and according to the aforementioned author, fish is the dominant and most utilized resource. However, its utilization remained relatively uncommon until the 1970s when development policies began focusing on aquatic resources.

In the majority of African countries, unmonitored fishing could constitute more than 60% of all fishing (Lévêque & Paugy 1999). The species which are most often caught are tilapia from the Cichlidae family, catfish from the Clariidae family and Nile perch from the Centropomidae family. Fresh catch is often sold at the landing piers, and when there is a drop in sales, either the fishermen or the ATP women (Women's Association of Fish Processors — *Association des Transformatrices de Poisson*) sometimes smoke or dry the fish. Post-capture damage to fish is often caused by coleopterous insects in the case of smoked fish (Watanabe, 1974, Osuji 1974, FAO 1981, Diouf 1987), and through damage in transit in the case of fresh fish. These insects belong to the Calliphoridae (blowflies) and Dermestidae families (skin beetles). Among fish belonging to the Clariidae fish family, the *Dermestes maculatus* beetle is the most significant in terms of smoked or dried fish infestation (Osuji 1974, Dobie *et al.* 1993). At the Hippopotamus Lake, the same traditional techniques are used as in the majority of small-scale fisheries, and have been described by Kabré *et al.* (2003). These authors listed the different types of smokehouses and established comparisons between the costs of utilization and profitability of three improved smokehouses (the smokehouses Monoclaie, Dafing and Chorkor).

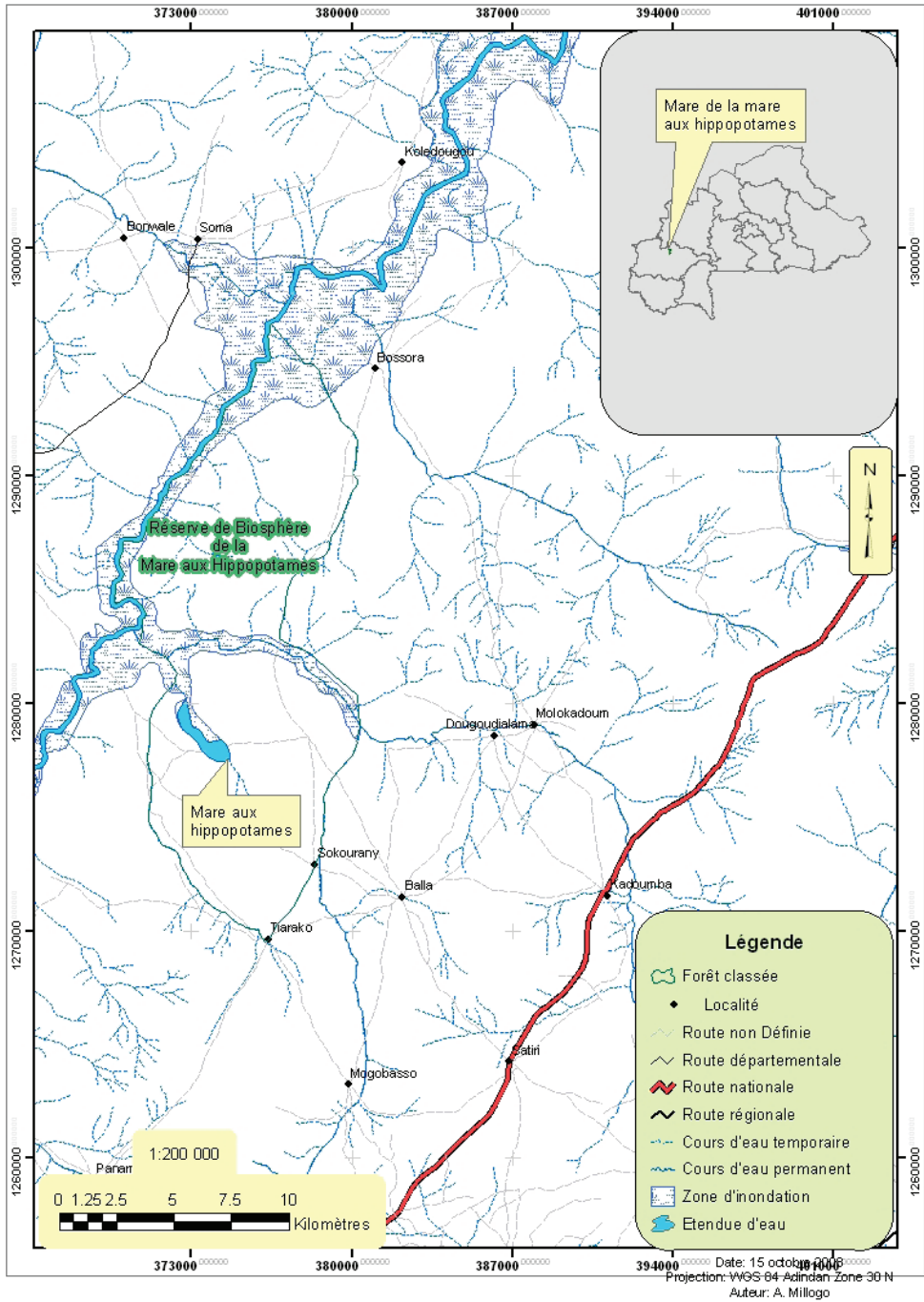


Figure 1: Location map of the Hippopotamus Lake (Burkina Faso)

Much like all the other stretches of water in Burkina Faso, the Hippopotamus Lake has been a small-scale fishery for decades and is visited by national fishermen on a daily basis. These fishermen are organized into groupings at the landing piers and are supervised by the fishing services as well as the MAB project, NGOs and research organisations.

This study aims to describe certain aspects of the Mare aux Hippopotames Biosphere Reserve's ecology and analyse the use of post-capture fish products.

2. Methodology

2.1 Location of the Mare aux Hippopotames Biosphere Reserve and the fishermen's villages of origin

The Mare aux Hippopotames Biosphere Reserve is situated in the high basins 40 km north-west of the city of Bobo-Dioulasso. Figure 1 shows the location of the lake and the home villages of the fishermen visiting the lake. With an area varying between 120 and 660 ha, this perennial lake harbours a wealth of approximately 34 fish species, according to the 1995 list (Kabré *et al.* 1997). Tilapia constitutes the majority of catch species (60%).

Since its classification in 1937, fishing has always been one of the activities conceded to the riparian populations by the colonialists. Today, the utilization of this resource continues, with around sixty fishermen originating from the Balla, Tiarako and Sokourani villages. The activity plays an ever more important role in the household economy of the reserve's riparian populations.

2.2 List of fish species populations and data collection on fishing

An inventory was conducted in 1995 with the support of the Man and Biosphere (MAB) project, whereafter all investigations into the lake's fish populations and management of fish stocks have been based on the results of this inventory. Several techniques were used to capture numerous species of fish inhabiting the lake, namely a) net fishing (gill nets and cast nets), fish traps, long lines (all of these equipment are used by the fishermen), b) experimental fishing using a battery of gill nets, and c) electro-fishing using a well-equipped outboard motor boat. Fishermen were intercepted and interviewed as they were going out on their landing piers, in other words, using the on-site creel interview method. Fish species were identified either on site with the help of illustrated dichotomous keys of the families, genera and species, or at the laboratory for species which were more difficult to describe.

The creel interview method made it possible to observe the quantities of fish caught by the fishing apparatus, measure the biological production variables (weight, length, age and sex) and calculate the utilization rates, mortality rates and growth rates.

The production of a reservoir can be estimated using two methods: a) recording all catches during an entire year over a given period of time, b) using an empirical formula which uses the Morphoedaphic Index (MEI) developed by the researchers. In the case of the Mare aux Hippopotames Biosphere Reserve, the difficulties encountered in collecting reliable statistics on monitored catch at the landing piers impose the

use of Marshall's empirical formula for estimating production, a productivity estimation model based on the MEI. This index represents the relationship between the total dissolved solids, or electrical conductivity measured during high water level periods expressed in $\mu\text{s}/\text{cm}$, and the average depth of the water during high water level periods expressed in metres. The frequently used model developed by Marshall is based on 11 African lakes and provides satisfactory results:

$$\text{Usable production (kg/ha/year)} = 23.281 \times \text{MEI}^{0.447}$$

2.3 Collection of benthic insects for identification

A sampling of the lake's benthic invertebrate community was conducted using a geological bottom grab sampler. The experimental system comprised 12 transects which were 100 m apart and were directed from the bank towards the median line of the lake bed. Collecting benthic samples entailed sampling the silt of the lake bed twice, using the grab at each of the three observation stations. The observation stations were aligned on the same transect in the following manner: the first station at 1 m outside the water boundary (station P-1), the second station at 1 m inside the water line (station P+1) and the third at 10 m inside the water line (station P10). These three stations were moved along the water boundary every day of the sampling period. At each sampling, the grab scraped the silt of the lake bed over an area of 600 cm^2 . A combination of two sub-samples taken at each point made up each of the 648 collected samples. This procedure made it possible to increase the chances of obtaining sufficient amounts of biological information. The collected benthos was successively deposited into three 4 mm-, 1 mm- and 400 μm -thin mesh sieves, allowing invertebrates and all particles of a smaller diameter than the mesh to pass through. Using a magnifying glass, the silt was further sifted and large insects as well as their casings (sheaths) and pupal cells were extracted from the first sieve. The final sample (particles and macro-invertebrates of various diameters) was preserved in a jar containing formalin diluted to 5%, and then transported to the laboratory for insect identification.

2.4 Identification of insect families and genera

Chiromidea taxa were identified by means of the ORSTOM iconographic catalogue (Déjoux *et al.* 1983) and Durand's and Lévêque's publication (1981). Other specialized publications (Guenda 1996) also served as guiding documents in describing certain characteristics. Oligochaeta were identified using the identification illustrations and keys of Brinkhurst and Jamieson (1971).

The identification of molluscs was performed using the images and identification keys of Adam (1960). The taxa which were not represented by the aforementioned works were identified at a later stage with the identification keys and illustrations of Micha and Noiset (1982) as well as the key developed by Merritt and Cummins (1984).

Insects were placed into a petri dish and observed using binocular magnifying glasses. All insects (adults and larvae), their casings and remains (houses and body parts) were selected and then identified.

2.5 Study of fish diet

The stomachs of 226 *Gymnarchus niloticus* subjects and 116 *Hemichromis fasciatus* subjects were collected for analysis of their macro invertebrate content. The collected stomachs came from catch which was in a good condition, whereas putrefying individuals were systematically excluded from the sample. The sampled stomachs were preserved in 200 ml flasks filled with formalin solution diluted to 7%, and then transported to the laboratory for analysis. At the laboratory, the stomachs were opened and their contents were deposited into petri dishes which were placed under a microscope for observation of the remains or intact specimens of ingested invertebrates.

2.6 Fish preservation by means of lemon juice

A total number of 1 680 fresh fish including 840 tilapia (Figure 2) and 840 catfish (Figure 3) were bought from wholesale fish merchants at the Sourou fisheries (Dédougou province) and the Hippopotamus Lake (Satiri department). The fish were washed with water and then smoked by a woman doing fish processing (ATP woman) before being transported to the laboratory for infestation. Strains of the *Dermestes maculates* insect (Figure 4), were collected on smoked fish sold at the Bobo-Dioulasso market and used to infest the fish included in the different experiments.



Figure 2: Fresh tilapia fish purchased from wholesale fish merchants and intended for smoking



Figure 3: Fresh catfish purchased from wholesale fish merchants and intended for smoking



Figure 4: *Dermestes maculatus* collected on fish sold by fish merchants at the Bobo-Dioulasso market and used to inoculate the batches of smoked fish

Figure 5 shows that 840 tilapia were divided into 2 batches of 420 individuals each, and used as subjects in experiments I and II, which corresponded to the prevention and control of *Dermestes maculates* infestation, respectively.

Lastly, fish from each replicate were dried and weighed together before being stored in plastic boxes for 8 weeks. During these 8 weeks, weight and levels of infestation were observed at the end of every week (more specifically, on Saturdays). Lemon juice was

extracted from ripe fruit and then filtered, whereafter its pH value was measured to be 2.7. Three solutions of varying concentrations were prepared using the lemon juice mixed with water, in order to obtain 3 different concentrations of lemon juice: 10%, 20% and 30%, with respective pH levels of 3.55, 3.26 and 3.19. The control solution, treatment T₁, contained water only (i.e. 0% lemon juice), with a pH of 7.08. The other treatments, T₂, T₃ and T₄ represent the other 3 concentrations of 10%, 20% and 30%, respectively.

2.7 Data processing

Fish caught were opened and their stomachs were removed. Subsequently, the stomachs were also opened and their contents analysed in order to calculate the occurrence and abundance indices (Hyslop 1980, quoted by Lévêque & Paugy 1999).

Over the course of this study, the following parameters were observed: a) the decrease in weight per week, and b) the number of insects (i.e. the number of larvae and adult insects). The software program Excel 2007 was used for data capture. With regard to the

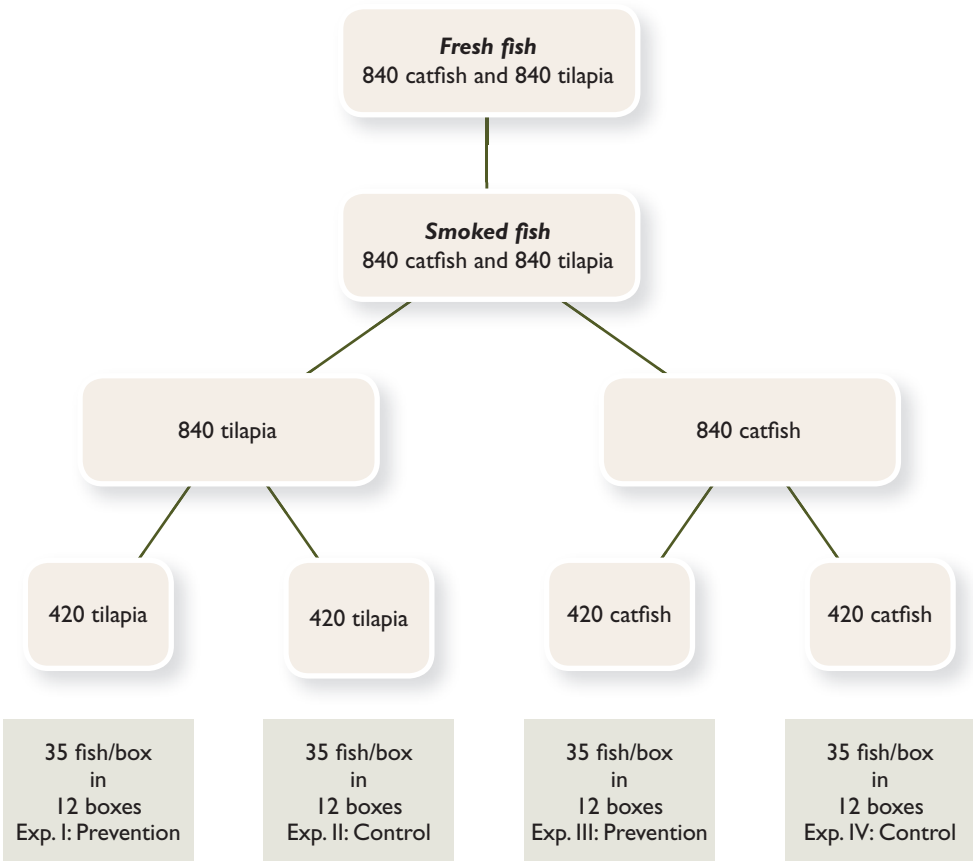


Figure 5: Experimental system used for preventing and controlling *D. maculatus* in tilapia and catfish in the small-scale fisheries of Burkina Faso

experimental data on fish preservation by means of lemon juice, the software program *xlstat* and Fisher's test were used. Lastly, the FISAT II program made it possible to estimate utilization rates and mortality rates as well as the selectivity values of the nets.

3. Results and discussion

3.1 Ecological and biological aspects of the lake's resources

An inventory of fish was conducted in 1995 with support from the MAB project and since then all work has been based on these results for the management of fish stocks. Table 1 shows the composition of the lake's ichthyologic population. After more than 10 years, which is the maximum sufficient period for the revision of this type of list, the fish inventory must be revised during the course of the next investigations. Compared to the known composition of the population of one of Burkina Faso's large fisheries (such as the Bagré fishery in the heart of the country), the Hippopotamus Lake (a natural lake) harbours an ichthyologic population which is more diverse than those of artificial stretches of water, despite its deteriorating biodiversity.

Table 1: Ichthyological list at the Hippopotamus Lake and Kou Valley, 1995. NB: the two stretches of water are from the same Volta basin.

Family	Number of species encountered	
	Hippopotamus Lake	Kou Valley
Anabantidae	1	1
Bagridae	2	2
Centropomidae	1	0
Characidae	1	1
Cichlidae	6	5
Citharinidae	1	0
Clariidae	2	1
Cyprinidae	2	2
Distichodontidae	1	1
Gymnarchidae	1	1
Malapteruridae	1	1
Mochokidae	2	2
Mormyridae	6	5
Ophiocephalidae	1	1
Osteoglossidae	1	1
Polypteridae	2	2
Protopteridae	1	1
Schilbeidae	1	1
Tetraodontidae	1	0

On the other hand, from a utilization point of view, the fishing activities in the artificial reservoir of Bagré are more organized and focus on a large variety of fish species stemming from several families. This cannot be said of the lake, where ineffective equipment and a lack of professionalism among fishermen only allow for the use of tilapia from the Cichlidae family, silurids or catfish from the Clariidae family, Nile perch from the Centropomidae family and *Gymnarchus niloticus* from the Gymnarchidae family. However, Nile perch from the Centropomidae family, featuring in the 1995 lists at the Hippopotamus Lake, is rarely caught and is currently an endangered species. The species was most likely overfished during the high water level periods of the Mouhoun River when the species migrate towards the Hippopotamus Lake. Moreover, according to the literature (Lévêque & Paugy 1999), the deterioration of the lake's environment due to silting (in particular) provides inadequate conditions for the survival and reproduction of the Nile perch.

Table 2 shows the species diversity of macro invertebrates, and Table 3 indicates their role in the diet of fish. For the majority of the Sahel's reservoirs, the shrinkage of water surface areas combined with the phenomenon of silting have also led to habitat loss for aquatic life forms, particularly for benthic fish and macro invertebrates. These macro invertebrates constitute a food base frequently used by fish, and belong to a group of organisms (especially in their larval and nymphal stages) which are not well-known in Burkina Faso.

Table 2: Benthic macro invertebrate populations collected in the tidal range zone at 1 m outside the water boundary of the Hippopotamus Lake during the seasonal low water level period from March to May.

Order	Number	Frequency	Family	No. of individuals
Diptera	1421	45.43	Chironomidae	503
			Canaceidae	2
			Ceratopogonidae	898
			Tabanidae	15
			Muscidae	1
			Tipulidae	2
Ephemeroptera	24	0.77	Caenidae	22
			Potamanthidae	1
			Ephemeridae	1
Trichoptera	12	0.39	Ecnomidae	1
			Philopotamidae	6
			Polycentropodidae	5
Odonata	8	0.26	Gomphidae	3
			Libellulidae	5
Lepidoptera	1	0.03	Noctuidae	1
Hemiptera	1	0.03	Nepinae	1

Order	Number	Frequency	Family	No. of individuals
Orthoptera	5	0.16	Gryllotalpidae	5
Coleoptera	570	18.22	Dytiscidae	7
			Hydrochidae	6
			Hydraenidae	135
			Hydrophilidae	53
			Staphilinidae	369
Oligochaeta	246	7.86	Naididae	246
Mollusca	840	26.85	Planorbidae	554
			Valvatidae	286

The macro invertebrates of the benthos are essentially molluscs, oligochaetes and particularly insects. It is a well-known fact that several insects, even those which live on land when they reach their adult stage, complete their larval and nymphal development in water. In total, 648 benthic samples were collected for research and insect identification, including 540 samples collected during the high water level period (September to January) and 108 samples collected during the low water level period (February to April). A total population of 11 195 individuals was identified from the samples. In order to compile this list, a geological bottom grab sampler was used during sampling and allowed to identify insects (67.52% of the macro invertebrate population), molluscs (25.72%) and oligochaetes (6.76%). Insects came from 9 orders and 48 families, mainly dominated by the dipterans. Two families of molluscs were identified, namely the Planorbidae and Valvatidae, whereas oligochaetes were represented by a single family, the Naididae. The study made it possible to show that an increasing loss in macro invertebrate biomass occurs simultaneously with the progressive shrinkage in water surface area. The invertebrates which are the most affected by damage resulting from this shrinkage are the dipterans (Table 2). The other types of macro invertebrates (molluscs, oligochaetes and insects) also decrease. This study shows that the shrinkage of water surface areas causes great losses in the macro invertebrate populations of the lake, resulting in biodiversity deterioration and loss of food sources for the growth and biomass production of fish.

Macro invertebrates play a vital role in the diet of fish as they constitute the base of the food chain in the aquatic system and the biomass production of fish. All species of fish consume macro invertebrates at some stage of their development. For example, the diet of the *Gymnarchus niloticus* species from the Gymnarchidae family varies according to its stage of development: young alevins first consume zooplankton and then macro invertebrates before becoming piscivorous in their adult stage. Of the 226 stomachs observed, 162 contained at least one type of prey and 63 (or 27.88%) were empty. A total number of 1002 types of prey, i.e. an average of 4.43 types of prey per stomach, were identified. The study shows that the number of empty stomachs is higher during the low water level period between February and April, and that this number

(42.5%) is higher among physically larger fish than among younger individuals (38.71%) (Table 3a). The occurrence and abundance indices follow the same trend, with a general decrease in prey categories during the low water level period. Our investigations into the *Hemichromis fasciatus* species, a small piscivorous species from the Cichlidae family, show that young individuals consume insects before becoming piscivorous in their adult stage. Of the 116 examined stomachs, 38 stomachs, or 32.76%, were empty. The study identified 324 specimens of prey, i.e. a rate of 2.8 specimens of prey per stomach. Much like among *Gymnarchus niloticus*, an increase in the number of empty stomachs was noted during the low water level period. The largest individuals accounted for 58.33% of the empty stomachs and the smaller individuals accounted for 36.11% of the empty stomachs during the low water level period (Table 3b).

Table 3a: Results regarding prey identified in the stomachs of *Gymnarchus niloticus* during the high water level periods and low water periods of the Hippopotamus Lake

	High water level periods				Low water level periods			
	TL* = 120–299		TL* = 300–750		TL* = 120–299		TL* = 300–750	
	Number	%	Number	%	Number	%	Number	%
Stomachs examined	90	100	34	100	62	100	40	100
— empty	14	15.56	8	23.53	24	38.71	17	42.5
— not empty	76	84.44	26	76.47	38	61.29	23	57.5
Total stomachs	124				102			
Prey per stomach	4.91		4.7		3.98		3.17	
Food	Frequency %		Frequency %		Frequency %		Frequency %	
	<i>I. occ</i>	<i>I. ab</i>	<i>I. occ</i>	<i>I. ab</i>	<i>I. occ</i>	<i>I. ab</i>	<i>I. occ</i>	<i>I. ab</i>
Insects	97.36	96.1	96.15	83.09	100	94.44	82.61	86.18
Libellula (Odonata)	76.31	70.56	50	57.04	94.73	89.24	78.26	86.18
Orthoptera	6.58	1.25	23.07	15.5				
Ephemeroptera	28.95	10.44	23.07	4.22	5.26		0.8	
Lepidoptera	13.16	7.1	3.84	5.63	2.63		2	
Diptera	13.16	6.05			5.26		2.4	
Unspecified	1.3	0.22	3.84	0.7				
Fish	19.74	3.13	53.85	12.67	15.79	3.2	39.14	7.31
<i>Barbus</i> spp	1.3	0.21	15.38	3.52	2.63	1.2	13.04	2.44
<i>Tilapia</i> spp	10.52	1.67	23.07	6.34	5.26	0.8	17.4	3.25
Unspecified	7.9	1.25	15.38	2.81	7.9	1.2	8.7	1.62
Plant debris	5.26	1.04	11.54	3.52	13.16	2.4	13.04	6.5
Molluscs	1.3	0.2	3.84	0.7				

*TL = total length in mm

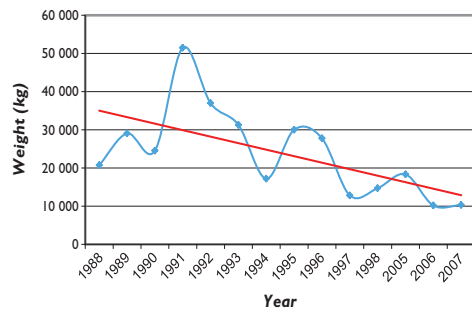
Table 3b: Results regarding prey identified in the stomachs of *Hemichromis fasciatus* during the high water level periods and low water periods of the Hippopotamus Lake

	High water level periods				Low water level periods			
	TL* = 110–179		TL* = 180–250		TL* = 110–179		TL* = 180–250	
	Number	%	Number	%	Number	%	Number	%
Stomachs examined	34	100	22	100	36	100	24	100
—empty	6	17.65	5	22.73	13	36.11	14	58.33
—not empty	28	82.35	17	77.27	23	63.89	10	41.67
Total stomachs	56				102			
Prey per stomach	4.17		1.5		3.44		0.92	
Food	Frequency %		Frequency %		Frequency %		Frequency %	
	<i>l. occ</i>	<i>l. ab</i>	<i>l. occ</i>	<i>l. ab</i>	<i>l. occ</i>	<i>l. ab</i>	<i>l. occ</i>	<i>l. ab</i>
Insects	82.14	80.43	52.94	49.99	91.3	95.91	80	77.78
Libellula (Odonata)	67.86	29.35	35.29	31.25	78.26	82.65	70	77.78
Orthoptera	3.57	1.08	5.89	3.12				
Ephemeroptera	17.86	11.96			8.69	2.04		
Lepidoptera	3.57	5.43	11.76	15.62	13.04	3.06		
Diptera	17.86	32.61			13.04	8.16		
Unspecified	42.85	15.21	76.47	43.74	11.59	3.06	30	22.22
Fish	3.57	1.08	5.89	3.12	8.69	3.06	20	7.41
<i>Barbus</i> spp.	7.14	3.26	29.41	21.87				
<i>Tilapia</i> spp.	25	0.87	35.29	18.75	20	14.81		
Unspecified	10.71	4.35	5.89	6.25	4.35	1.02		
Plant debris	3.57	1.08						
Molluscs								

*TL = total length in mm

3.2 Production and utilization of the lake's fish

Based on Marshall's model, the usable production of the lake is estimated at 39 metric tons per year. This amount gives an average yield of 280 kg/ha/year, which is an exceptional amount considering that Burkina Faso's average piscicultural yield is between 50 and 100 kg/ha/year (Ouédraogo 1998). This distinctive yield is attributed to favourable ecological conditions in the middle of the lake (numerous

**Figure 6:** Progress of catch at the lake from 1988 to 2007

habitats and species, abundant vegetation, a significant spawning area). The estimates have made it possible to generate the progress model for annual catch in Figure 6.

On the other hand, the caught fish are small in size, which confirms the lack of professionalism among the fishermen, who use ineffective equipment compared to the fishermen working in the large Bagré fishery.

3.3 Development of a preservation method using lemon juice against *Dermestes maculatus*

The results are significant ($P < 0.01$), according to each treatment. Fish weight decreased over the 8 weeks of preservation (Figures 7 and 8), and insects began reproducing (Figures 7 and 8). The results presented in the two tables were interpreted as follows:

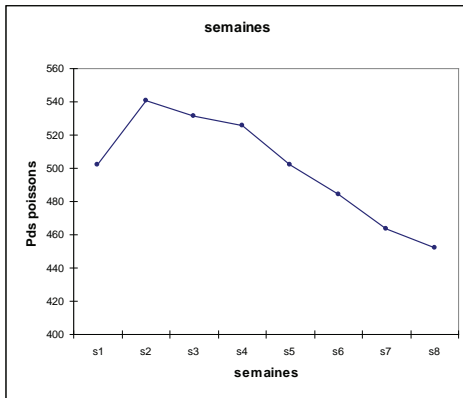


Figure 7: Evolution of the average weekly weight of smoked catfish and tilapia subjected to preventive treatments

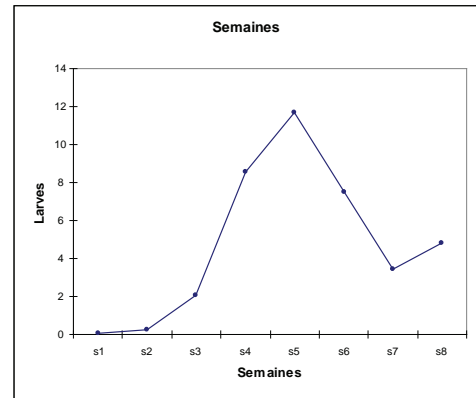


Figure 8: Evolution of the average weekly number of larvae in smoked tilapia and catfish subjected to preventive treatments

3.3.1 Experiments on tilapia and catfish: infestation prevention

Table 4 provides the results regarding weight decrease and the number of insects per treatment. The 0%, 10%, 20% and 30% treatments led to respective decreases (expressed in percentages) of 13.57%, 0.48%, 26.49% and 18.69% among the tilapia and 21.11%, 12.46%, 6.8% and 12.43% among the catfish. The average losses were compared using Fisher's Least Significant Difference at a probability level of 5% (FLSD_{0.05}), and the results were presented in Table 4. It appears that in the case of the tilapia, the 10% and 20% treatments were significantly different, whereas in the case of the catfish, the 0% and 20% treatments presented significant differences. When comparing the insects' survival rates for each treatment among the tilapia, values (expressed as %) of 10%, 0%, 10% and 20% were recorded for the 0%, 10%, 20% and 30% treatments, respectively, whereas among the catfish, the corresponding values were 0%, 0%, 40% and 20%, respectively.

In other words, the two observations on weight decrease and survival rates show that the 10% treatment is the most effective in preventing *Dermestes maculatus* infestation in tilapia and catfish.

Table 4: Weight loss of smoked fish in the insect infestation adults and larvae (*Dermestes maculatus*) in tilapia and catfish from artisanal fisheries in the Hippopotamus Lake and Sourou dam lake, Burkina Faso

Fish Species	Treatments	Initial weight after spraying and drying	Final weight	Weight loss	Number of adult insects used to inoculate	Numbers of adults one week after spraying	Numbers of adults eight weeks after inoculation	Number of larvae one week after inoculation	Number of larvae eight weeks after inoculation
Tilapias	0%	571,90	494,30	77,60	10	3	1	0	1
	10%	565,40	562,68	2,72a	10	3	0	0	0
	20%	570,15	419,12	151,03a	10	0	1	0	6
	30%	478,45	389,01	89,44	10	0	2	0	3
					LPDSF _{0,05} = 109,58				
Clarias	0%	827,28	652,62	174,66a	10	0	0	0	9
	10%	852,04	745,82	106,22	10	0	0	0	10
	20%	923,13	860,36	62,77a	10	0	4	0	6
	30%	852,81	736,80	106,01	10	0	2	0	5
					LPDSF _{0,05} = 90,65				

NB: LPDSF means Smallest Significant Difference Fisher at 5% probability. The average loss of weight loss treatment and species with the same letters are significantly different.

3.3.2 Experiments on tilapia and catfish: infestation control

In experiments II and IV, which were aimed at controlling infestation, the 2 batches of 420 tilapia and 420 catfish were both subdivided into 4 groups of 3 replicates per group. The fish of each replicate were inoculated with 10 insects and, one week later, sprayed with the doses of lemon juice prescribed in the experimental system. In other words, group 1 was sprayed with treatment 1 (0% lemon juice), group 2 with treatment 2 (10% lemon juice), group 3 with treatment 3 (20% lemon juice) and group 4 with treatment 4 (30% lemon juice). The following step of the process involved placing the fish into a dryer and exposing them to sun radiation. Kabré *et al.* (2003) indicate that the radiation intensity exerted on the ground is 1864 (joules/cm²/day) from January to May, or an average of 2076 joules/cm²/day in the central east. The fish were subsequently transferred to the laboratory where they were shielded from sunlight, weighed and stored during the whole incubation period of 8 weeks. During these 8 weeks, the fish were regularly and

systematically weighed at the end of the week (more specifically, on Saturdays). The infestation levels were also observed at the end of each week. Table 5 contains the results of our observations on the decrease in weight and the number of insects per treatment. Among the tilapia, the 0%, 10%, 20% and 30% treatments led to decreases of 22.68%, 11.85%, 29.74% and 29.70%, respectively. Among the catfish, decreases of 1.49%, 7.28%, 8.09% and 20.97%, respectively, were recorded. The average losses were compared using Fisher's Least Significant Difference at a probability level of 5% (FLSD_{0.05}), and the results are presented in Table 5. In the case of the tilapia, the 0% and 20%, 10% and 20%, and 10% and 30% treatments were significantly different, whereas in the case of the catfish, only the 0% and 30% treatments presented significant differences.

Table 5: Weight loss of smoked fish in the insect infestation adults and larvae (*Dermestes maculatus*) in tilapia and catfish from artisanal fisheries in the Mare aux hippos and Sourou dam lake, Burkina Faso. Initial and final weight loss, numbers of adults and larvae.

Fish Species	Treatments	Initial weightin (g) after spraying and drying	Final weightin (g)	Weight loss in (g)	Number of adult insects used to inoculate	Numbers of adults one week after spraying	Numbers of adults eight weeks after inoculation	Number of larvae one week after inoculation	Number of larvae eight weeks after inoculation
Tilapias	0%	532,44	411,68	120,76a	10	3	1	0	1
	10%	683,60	602,58	81,02bc	10	3	0	0	5
	20%	655,41	460,51	194,90ab	10	3	0	0	8
	30%	537,48	377,83	159,63c	10	0	0	0	3
				LPDSF _{0,05} = 73,86					
Clarias	0%	680,7	579	10,17a	10	3	1	1	23
	10%	759,45	704,13	55,32	10	1	0	0	5
	20%	870,68	800,24	70,44	10	4	0	0	4
	30%	973,18	769,14	204,04a	10	4	10	0	1
				LPDSF _{0,05} = 163,44					

NB: LPDSF means Smallest Significant Difference Fisher at 5% probability. The average weight loss per treatment and per species with the same letters are significantly different.

When comparing the insects' survival rates for each treatment, the values (expressed in %) in the case of the tilapia were 10%, 0%, 0%, and 0% for the 0%, 10%, 20% and 30% treatments, respectively, whereas the corresponding values for the catfish were 10%, 0%, 0% and 100%, respectively.

In other words, the two observations on decreases in weight and the survival rates make it possible to state that the 10% treatment was the most effective in controlling *Dermestes maculatus* infestations in tilapia and catfish.

The adult insects' survival rates in Tables 4 and 5 presented above clearly show that lemon juice has a lethal or acute effect according to the treatment and the persistence of the treatment's effect. During the two types of experiments (prevention and control), we demonstrated that the 10% lemon juice treatment provides the best results in terms of inhibiting the reproduction and development of the *Dermestes maculatus* population, with the consequence of low biomass losses in smoked fish. Odeyemi *et al.* (2000) observed that larvae cause more damage than adults, due to their rapid growth and development. Our study's results coincide with previous authors' results. In fact, in 1989 at the Kainji Lake in Nigeria, 20% lemon juice was sprayed onto smoked fish against *Dermestes maculatus* infestations. Reductions in weight losses of 10.91% and 9.92%, respectively, were observed in the control and prevention experiments on catfish (James 1989).

Damage caused by Dermestidae may affect up to 50% of the fish's weight (Haine & Reeps 1989). This makes it possible to confirm that the results of the present study have clearly shown that the 10% lemon juice concentration is effective in preserving fish. It significantly reduces the damage caused by *D. maculatus* (losses of 0.4% to 7.28% were observed).

4. Conclusion

The Mare aux Hippopotames Biosphere Reserve is primarily utilized by fishermen from three riparian villages, namely the Balla, Sokourani and Tiarako villages. The majority of fishermen are agro-fishermen, which means that they practise fishing as a secondary activity. Owing to its favourable ecological and biological features, the lake is a productive fishery. Its production is estimated at more than 34 metric tons of fish per year, or a yield of more than 300 kg/ha/year. Despite good productivity, the piscicultural resources are threatened by overfishing trends and by the deterioration of aquatic ecology due to silting and aquatic vegetation overgrowth.

With regard to the preservation of fish, the support of the MAB project at the Fishery and Fauna Research and Training Laboratory (*Laboratoire de Recherche et de Formation en Pêche et Faune — LaRFPF*) allowed for the development of a preservation method using lemon juice. The results show that the 10% lemon juice solution prevents and controls *D. maculatus* infestations in tilapia and catfish by reducing damage occurring during storage. This method supports traditional methods of fish smoking and drying which were already well-known among the fishermen and ATP women of the Mare aux Hippopotames Biosphere Reserve. Lastly, the study emphasized the induced effect of habitat loss during seasonal low water levels and the lake's silting on the decrease in species biodiversity of fish and macro invertebrate populations.

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AFRIMAB

BIOSPHERE RESERVES IN SUB-SAHARAN AFRICA:
SHOWCASING SUSTAINABLE DEVELOPMENT

Africa is a vast continent of more than 30 million square kilometres, covering a fifth of the Earth's total land area and housing 15 percent of the human population of the world. Sub-Saharan Africa covers about 23 million square kilometres and is made up of 48 countries. UNESCO's Man and the Biosphere Programme is active throughout Africa. AfriMAB is the sub-regional network of biosphere reserves for Sub-Saharan Africa and currently includes 64 biosphere reserves in 28 countries.

Biosphere reserves have to conform to specific guidelines in accordance with the MAB Programme, which addresses a specific designation of functions and zonations. Globally, biosphere reserves are considered as sites of excellence where new and optimal practices in the management of the interface of nature and human activities are tested and demonstrated. The MAB Programme is used as a tool to help countries implement the objectives of the World Summit on Sustainable Development as well as the Ecosystem Approach of the



Convention on Biological Diversity, UNESCO has drafted the Madrid Action Plan for Biosphere Reserves (2008-2013) that provides an evaluation framework for the World Network of Biosphere Reserves. In accordance with this Plan, biosphere reserves are positioned to create a new partnership between environmental and development agendas. In Africa, projected to be the fastest growing region in the World, this is an imperative concept to ensure sustainability.

This publication on biosphere reserves in Sub-Saharan Africa is the culmination of an idea that had its origin at an AfriMAB meeting in Nairobi, Kenya in 2010. The book is aimed at exchanging information, providing for learning experiences, and creating awareness of the MAB Programme and its value towards sustainable development in African countries.

Readers are invited to share our stories, in an intellectual and emotional way, and to experience life in biosphere reserves as it plays out on a daily basis in our beloved Africa.